


newscientist



The birth of consciousness



"It's got to be Gordon's."

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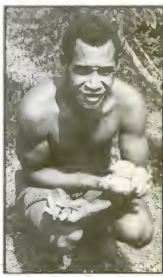
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This One



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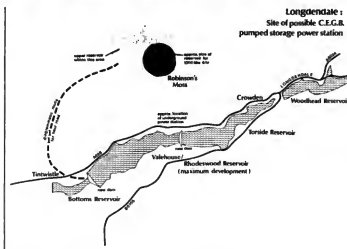
National Park faces the scars of electricity scheme

A PLAN TO DESECRATE part of the Peak District National Park for a scheme to store electricity will lead to a furious row when details are published this autumn.

The Central Electricity Generating Board (CEGB) wants to build a £500 million "pumped storage" power station in the heart of the park, starting later this decade. The idea is to "store" electricity by using off-peak power to pump water uphill to a high-level reservoir at night. Then in the daytime when demand for electricity is higher, the water will be released to cascade downhill through generating turbines to the lower reservoir. Such schemes will be an integral part of any future development of nuclear power plants in Britain. The proposed scheme would be in Longdendale, close to the High Peaks. Construction will involve:

- Raising the level of existing reservoirs in the dale (which supply water to the Greater Manchester area) by up to 40 metres and flooding part of the dale to create the lower reservoir.
- Building a road for heavy lorries, which will climb 300 m from the village of Tintwistle in the valley floor to the top of Robinson's Moss, the remote, flat-topped moor which can at present be reached only on foot
- Removing 1.5 million cu. m of peat from the top of Robinson's Moss to open up a 55 hectare hole, 20 m deep, for the upper storage reservoir. This massive operation would involve some 150 000 lorry loads of peat trundling down the hillside.

The whole project will cost some £500 million, according to engineering consultants Binnie and Partners. If it goes



Pumped storage comes to the Peak District

ahead, it would be one of the biggest civil engineering projects of the 1990s.

The Peak Park Joint Planning Board has decided to oppose the plan outright as a "horrible scar in a very beautiful valley". Apart from the destruction of Robinson's Moss and the arrival of overhead power lines in the park, the Peak

Fred Pearce

board believes, "The main problem is the bottom reservoir where there is going to be a very big difference in the level between night and day".

In April, the Council for Europe presented the Peak board with its European Diploma for Nature Conservation as one of Europe's best-protected areas. But the board was told that the diploma would not be renewed if the electricity scheme went ahead.

A preliminary assessment of the environmental impact of the project has been prepared by staff at the CEGB. The Peak board is pressing the CEGB to publish the report in full to encourage public debate about the scheme. But the CEGB told *New Scientist* this week that it would only publish the conclusions this autumn. Nonetheless, the Peak board will use the occasion to launch a major assault on the plan.

The next step for the CEGB will be a technical assessment, involving a detailed geological survey of the site for the underground power station and the route of the tunnels that will link the two reservoirs. This assessment alone could cost £15 million.

A further disruption to the Longdendale Valley will be the raising of the nearby Torside reservoir by 5.8 m. This will compensate the North West Water Authority for loss of water from the Valehouse reservoir. It will be important for the CEGB to keep on the right side of the water authority, since it owns all the land on which the station and reservoirs are to be built.

According to the Peak board, the CEGB intends to get permission for the

scheme through a Parliamentary Bill. This would probably go before MPs in the early months of the next Parliament.

Construction would take 10 years, so the station would not join the national grid until almost the end of the century. It will complement the CEGB's first large pumped storage scheme at Dinorwic, North Wales, which should come on stream next year.

The Peak Park scheme will generate 1500 MW of electricity for up to six hours—similar to the capacity of Dinorwic. Pumped storage schemes will be an increasing feature of the electricity industry in the coming decades if nuclear power makes further inroads into the generating system.

Nuclear power stations cannot economically be turned on and off to meet changing demand for electricity at different times of the day. Thus, if their combined capacity exceeds minimum night-time demand it becomes economic to install storage schemes.

The Peak District provides a rare opportunity for pumped storage close to several highly-populated areas.

(There are more people within 90 km of Longdendale than within 90 km of central London.) It gives maximum flexibility for the national grid. But the Peak board is adamant that there must be alternatives. Either a different site, outside the Park, should be chosen, or alternative storage methods—such as air pressure storage now under development by the CEGB's scientists—should be explored.

As a recent briefing document from the Peak board noted, "If National Park status means anything, we should not be considering this sort of thing in a National Park". □

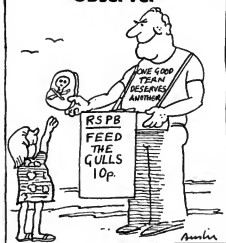
Satellite accord

COUNTRIES from the Third World have won a guarantee from the industrialised nations that they will have the right to inspect all data concerning their territories taken from remote sensing satellites.

The resolution at the Unispace conference in Vienna will have to be approved by the UN General Assembly, but it will reduce the fears of developing nations that operators of remote sensing satellites will pass on such data, without their consent, to others.

The move came after pressure from Argentina. Britain at first resisted, saying that the guarantee could restrict access to remote sensing data. But delegates eventually climbed down as a gesture of cooperation. The satellites' present and future main operators—the US, the USSR, France and Japan—had nothing to say on the matter. □

Observer



T H I S W E E K

Scientists rush to support European synchrotron

EUROPEAN SCIENTISTS planning a new source of synchrotron radiation for the late 1980s won a big boost for their efforts last week. It was reported that over 1000 French and German researchers had come forward with experiments that could be performed only on such a machine.

The figures came from a questionnaire circulated among European scientists by the European Science Foundation (ESF), which has supervised the planning of the European Synchrotron Radiation Facility. Replies from Britain and Denmark are not yet complete.

The scientific case for the machine was discussed at an international conference on X-ray and VUV synchrotron radiation instrumentation held last week in Hamburg. Among the enthusiasts for the machine was Juan Bordas, a senior scientist at the European Molecular Biology Laboratory outstation at Hamburg. He presented a list of a dozen or so experiments in biology for which the new source would be essential. These include studies of the dynamics of conformational changes in biological molecules and how catalysed reactions occur in proteins.

The ESF published a four-volume report in 1979. This describes a possible design for the facility and makes the scientific case for it. At that time, the cost of the machine was estimated at 93 million (EEC) units of account (around £64 million). With further advances in technology being made by the day at laboratories around the world, the design has been updated.

The new version will incorporate 45 magnetic devices, called "wigglers", to produce intense beams of X-rays of various wavelengths from a stored beam of energetic electrons circulating in a ring



The synchrotron radiation source under construction at Daresbury

900 m in circumference. Other magnetic devices will bring the total number of beam lines up to about 100. Between one and three experiments can be fed with X-rays from each beam line. The new design would cost about 10 per cent more than the original version (allowing for inflation since 1979).

Ros Herman

While the science and technology progresses smoothly—aided by experience from the many sources just coming into service—the Synchrotron Radiation Source at Daresbury for example—the politics of winning financial support from a number of European countries is less straightforward. Only France is committed to building a new synchrotron radiation source in the near future. Britain is non-committal because it has just built a source of its own which it cannot afford to fund properly. West Germany has also been less than enthusiastic, preferring a high energy physics experiment called HERA, and a national source of neutrons.

Rumour has it, though, that the

climate of opinion in West Germany has changed recently, partly because of financial problems and partly through pressure from scientists who want access to a better source of synchrotron radiation than they already have. West Germany, it is thought, prepared to consider a deal that would involve some foreign support for HERA in return for participation in a European synchrotron radiation project and a contribution to the spallation neutron source now under construction at the Rutherford Appleton Laboratory in Britain.

Many European scientists are worried about being left behind in the race for the interesting results to be gained. They are looking jealously to the US, where the Brookhaven National Laboratory at Upton, New York, leads the field with its brand new source. Already it is planning a new machine that will cost \$60 million.

Japan already has a source called the Photon Factory near Tokyo. This was built in double-quick time (2½ years) and is due to start experiments in October. Even China is now building a source, which is due for completion in 1986.

While scientists in disciplines ranging from geology to molecular biology have already proved the scientific worth of synchrotron radiation, the interest is about to spread wider still. Already electronics companies are about to start experiments on using the intense X-ray beams to make integrated circuits. And doctors and physicists are combining their efforts to develop an improved method for detecting heart disease. It is not beyond the bounds of possibility that there will be a synchrotron radiation source in every major city by the year 2000. □

Government agency failed to act over arthritis drug

ELLI LILLY knew for months that Oraflex, as benoxaprofen is known in the US, was associated with adverse effects and deaths. Lilly won approval of Oraflex for distribution in the US on 19 April. Since then, 17 articles or letters to the editor have appeared either in the *British Medical Journal* or the *Lancet*, about the dangers of Oraflex, according to the Washington-based Public Health Research Group. These articles reported 12 deaths, 23 cases of jaundice, and phototoxicity (extreme sensitivity to sunlight) in all 14 patients studied for this adverse effect. With the ban on Opren (benoxaprofen's name in Britain), the company eventually withdrew the drug worldwide. But during the period after 19 April, Lilly aggressively marketed Oraflex. In just three weeks in

May, chemists in the US filled 64 000 prescriptions. Lilly spokesmen point out that adverse side effects to the kidney and liver, and gastrointestinal ailments, are common to the non-steroidal anti-inflammatory drugs (NAIDs) of which Oraflex is but one of 10 approved for use.

Sidney Wolfe, the director of the health research group, petitioned the US Food and Drug Administration on 17 June to ban the drug. The FDA declined. Wolfe points out that the FDA, two years ago during a more cautious period, refused to approve Oraflex because not enough was known about its side-effects. But the Reagan administration is in the process of speeding up drug approvals, pushed by arguments from the drug industry that it is losing its competitive edge because of the long

"drug lag" between development of a new drug and its official approval.

The FDA has egg on its face over its handling of Lilly's data. Its officials have admitted that data on jaundice submitted to it by Lilly researchers was misfiled, and thus overlooked when an application for approval of Oraflex was still pending. Lilly's willingness to provide all the facts is also in doubt. The FDA has been investigating charges that Lilly, along with other drug companies, has withheld some data on side effects found during clinical or animal trials with drugs including Oraflex. Last year, an FDA investigator advised the agency to file a criminal prosecution against Lilly. The FDA still has not acted on that recommendation. The FDA investigator has since left the agency. □

T H I S W E E K

Glimmer of hope ahead for Refusnik scientist

THE DIPLOMATIC BATTLE goes on for the Russian refusnik David Goldfarb, a microbiologist. At its congress last week in Boston, the International Union of Microbiological Societies voted almost unanimously to raise Goldfarb's case before an influential scientific committee under the International Council of Scientific Unions. The council has in the past been able to win long-sought exit visas from the Soviet Union.

Goldfarb has been denied permission either to attend foreign meetings or to take up a post at the Weizmann Institute in Israel. Among refusniks (Soviet Jews who seek to emigrate to Israel), Goldfarb is in a special position both because of his renown as a microbiologist and because his son Alex is already in the US, working as a microbiologist at Columbia University. But time is running out for his official excuse to leave Moscow: his invitation from the Weizmann Institute specifies that the position will be open until retirement. Goldfarb is 64.

The matter forced itself upon the IUMS because Goldfarb, former director of molecular genetics at the Soviet Academy of Sciences, is a member of the union's International Microbial Genetics Commission. As such, he received official invitations to the Boston meeting. His renewed request for a visa brought no response from the authorities at the last time of asking.

This is the first time Goldfarb's case was discussed formally in an international scientific forum, although last March nearly 200 biologists wrote independently to the Soviet Academy of Sciences pleading for his release. There

was almost no discussion of the IUMS's mildly-worded resolution before its adoption, and delegates from Eastern bloc countries made no comment. The delegate from the Soviet Union, forewarned by IUMS officers that the resolution was on the agenda, was not present. The resolution calls attention to the fact that Soviet treatment of Goldfarb is "contrary to the spirit" of resolutions passed by the International Council of Scientific Unions (IUMS hopes to be voted a member next month). ICSU has international clout; on its own IUMS has virtually none. Willis Wood, president of the American Society of Microbiology, which hosted the meeting, declined advice from Alex Goldfarb and from some

members of ASM to speak out publicly on Goldfarb's behalf. He said he did not want to antagonise Soviet members of IUMS or detract from the scientific meeting.

A related issue must be of even greater concern to IUMS members: the reason why Goldfarb is denied a visa. The Soviets count molecular biology as a state secret. Goldfarb, who worked before his dismissal from the Academy on phages and antibiotic-resistant "doesn't know any secrets", says his son. "Ovchinnikov (the Soviet Academy's head of biochemistry) has said from his point of view there are no secrets. The problem is that the KGB thinks he knows secrets." □

A giant LEP for the PM

ALL IN THE CAUSE of European unity, Prime Minister Margaret Thatcher dropped by at the European Centre for Nuclear Research (CERN) last week on her way to the Alps. On her last visit, scientists were planning Europe's biggest particle accelerator, the Super Proton Synchrotron; 12 years later, they have decided to build the world's biggest—the Large Electron-Positron machine (LEP).

So what did the PM think of all this? The official party reports that she wanted to know why CERN wanted a new accelerator and how much it would cost (about 40 per cent more than CERN's annual budget). But she did deem the project "definitely" worthwhile. The fundamental nature of matter may not be an election issue—but the comment will be a relief to British physicists at CERN. □



The big heat brings a plague on your houses

BBRITAIN'S HOT, humid weather earlier this month did more than make the population swelter. It produced a plague of fleas. Councils report a large increase in the number of people wanting their homes fumigated. And as the nation scratches its ankles, experts say the worst is yet to come.

The main culprit is our furry friend, the cat. Britain has an estimated 13½ million cats and many of them have fleas. A lot of the country's six million dogs also have cat fleas. An infested animal will have about 10,000 fleas in tow—enough to keep us all up to scratch.

Contrary to popular belief, cat fleas do not live on their hosts. A cat will carry an average of only 25 fleas at any one time. The fleas simply jump onto a cat for their daily meal, and then off again. John Maunder, consultant entomologist at the London School of Hygiene and Tropical Medicine told *New Scientist*, "They are hit and run raiders".

Fleas spend most of their time in the places where a cat sleeps. These places

can have a population of 2000 adult fleas, and another 8000 in various stages of development.

The cat flea's eggs hatch within about three days. The larvae shed their skins four times and feed on the droppings of adult fleas and on dust, most of which is human skin. After between three weeks and three months the larvae become pupae, and finally become adults after another three weeks to three months, although adults have emerged from 18-month-old pupae.

The larvae and pupae develop much faster in hot and humid weather, which accounts for the current plague. Maunder says, "It's going to be a bumper year". He claims that the flea population should reach its peak around the end of September. No one is sure quite how long an adult flea lives, but it is probably about two years.

Part of the problem is that we are making life much easier for the flea. Like the cat, it is a semi-tropical beast. Fleas can die of cold, but the spread of central heating has made our homes

much more acceptable residences. Maunder says studies show that the cat flea is extending its range northwards with a vengeance.

Fortunately cat fleas do not particularly care for human blood. Maunder says "We're very much emergency rations." But if somebody closes the door on a room which a cat inhabits, or if the cat dies, then the fleas become very hungry. They have been known to mount mass attacks on people, who can end up in hospital.

The flea bite is an allergic reaction to the insect's saliva. People who haven't been exposed to fleas don't react at first. They become more sensitive, reacting to the bite before they finally become insensitive. About half of humans react to flea bites, which is why people often say that they never get bitten. It's not true; they just don't react as others seem to.

Getting rid of fleas is a big problem. The best way, says Maunder—tongue firmly in cheek—is "to shoot the cat and move". □

T H I S W E E K

Housing shortage hits plans for science park

A PLANNING ROW has put in jeopardy an ambitious scheme to encourage new industries in a run-down part of South London. The Polytechnic of the South Bank, the capital's largest centre for technical education has spent two years planning and raising money for an extension called the South Bank Technopark at the Elephant and Castle, Southwark. The idea is to build a kind of urban science park to help scientists and engineers exploit their ideas by starting up small businesses and sharing central resources (*New Scientist*, 12 August, p 429).

The college raised money from the Department of Industry and the Sainsbury Trust to carry out feasibility studies, and on 10 August the Prudential Assurance Company announced that it would pay for the three-story building: about £4.5 million.

But three days before the official launch of the project, the local author-

ity, Southwark Council, told the college that the project would not get planning permission because the site was zoned for housing. The borough has 6129 families on its waiting list for homes: it started just 42 homes last year.

The decision was a bombshell for the people behind the Technopark project because the council's (non-elected) officers had informally told the college that there would be no problem. But the elected Labour councillors, who gained control in April, decided that the time had come to stop the erosion of housing in the borough, particularly because there are plenty of industrial sites nearby.

The Prudential's joint chief surveyor, Michael Mallinson, described the council's decision as "highly unsatisfactory... it will discourage ideas like this in the future". He said the company would be unlikely to fund a project on a site

that was not adjacent to the college.

The director of the polytechnic, John Beishon, is now in the embarrassing position of defending a City financial institution which wants to buy up land allocated for housing "even if there is no money around to build the houses". But he will try to work out a compromise; the director of the Technopark project, Jeffe Jeffers, is meeting the council this week.

The Town and Country Planning Act of 1971 obliges Southwark to consider any planning application that it receives. A spokesman for the council said: "With the cooperation of the Greater London Council and the Prudential it should be possible to accommodate both family housing and the Technopark." But the insurance company may not be happy with this idea: "The Prudential is not in the business of building council houses," the company's surveyor said. □

The comet also rises

THIS WEEK we should be treated to the first view of a comet for seven years. Although astronomers have discovered many fainter comets, none since comet West in 1975 has been bright enough to be visible to the unaided eye. This week's comet, named for its New Zealand discoverer, Rodney Austin, will not be particularly spectacular, but you should have little problem in finding it close to the familiar stars of the Plough.

Austin discovered the comet on 18 June, during its approach to the Sun and while it was still well outside the Earth's orbit. It crossed our orbit a month ago, and will reach its closest point to the Sun next Tuesday—passing just within Venus's orbit. The comet's elongated orbit is tipped up at almost a right angle to the Earth's. As a result, the comet has travelled virtually south-north in the sky. Comet Austin is now in the Great Bear, and during the next week it will move gradually right to left under the stars of the Plough (the seven brightest stars of the Great Bear). The diagram shows where to find the comet in the north-east part of the sky just after sunset. □



Where to look for comet Austin



High tech industry or housing: Southwark backs the homeless and a scheme for south London falters

Organic farming wins vote of confidence in US

ORGANIC FARMING in the United States received a boost last week when a bill promoting research into organic methods was approved by a committee of the House of Representatives. If the bill is enacted, the Department of Agriculture will fund research at six universities and provide information on organic farming through its agricultural extension service.

Interest in organic farming has been growing in the United States, especially after a 1980 report from the agriculture department, which concluded that organic farming can cut operating costs and reduce soil erosion, and that organic methods can be adapted to large-scale farming. Officials at the department estimate that 40 000 of the country's 2.4 million farmers use organic techniques. The committee heard from Dr Warren Sals of the University of Nebraska, a leader in organic research, that over two-thirds of the farmers who attended a recent university field day on organic farming were conventional farmers interested in adopting the new techniques.

The department opposed the bill. Officials told the committee that the department is sympathetic to organic farming, but cannot afford the \$14.5 million research programme the bill would establish.

But members of the committee questioned the department's attitude towards organic farming. The department currently spends only \$1 million of its \$430 million research budget on pure organic studies. The Agriculture Secretary, John Block, was recently quoted in a farming journal as saying that organic research is a "dead end".

Thomas Daschle of South Dakota, a member of the House committee, told departmental officials, "The record supports the assertion that you have downgraded organic farming... The emphasis has been on conventional farming all along. It's in our best self-interest to pursue other ways."

The bill, which was approved by a margin of 16 to 9, still has to pass through the House and then a similar process in the Senate. □

Australian astronomy at the crossroads

THE FUTURE of astronomy in Australia hangs in the balance and could be decided this week when Malcolm Frazer's government reveals its budget. Australian astronomers have been trying to persuade Frazer's cost-conscious government to commit itself to the large financial outlays they believe are needed for the instruments that will keep Australia at the forefront of astronomy in the 1990s. The budget this week will show whether they have succeeded.

Australian astronomy is riding on the crest of a wave. Major discoveries emerge almost weekly from the Australian National University's (ANU) Mount Stromlo and Siding Spring Observatory, the universities of Sydney, Monash and New South Wales, the Commonwealth Scientific and Industrial Research Organisation's (CSIRO) Radio-physics Division, and the Anglo-Australian telescope at Siding Spring. But astronomy has now entered the expensive "big science" phase of space telescopes and very large arrays of radio telescopes.

To keep ahead of the field, Australian astronomers are pinning their hopes on two ambitious projects. The first is a joint American / Canadian / Australian space telescope. This one-metre telescope, called Starlab, will "see" wavelengths from the far ultraviolet through the visible spectrum to the near infrared. It will be launched by NASA's space shuttle in 1989. The other is the Australian Telescope, the only very large array of radio telescopes planned south of the equator (*New Scientist*, vol 93, p 788). Both projects received setbacks from the government last year and if they are to go ahead both must win financial support when the government announces its annual budget.

Thanks to far-sighted decisions made more than 10 years ago, astronomers in Australia have at their disposal a remarkably comprehensive array of optical and radio telescopes with which to view the southern sky. The group of modern optical and radio telescopes at Siding Spring in New South Wales (which belong to the ANU and the Anglo-Australian Observatory) provides optical astronomers with an exceptional set of instruments. In addition, the ANU is building a fully automatic 2.4-metre telescope at Siding Spring. However, Australian optical astronomers will need access to the much greater resolution provided by space telescopes (which don't have to contend with the Earth's atmosphere) if they are to compete by the end of the century.

Arrays of telescopes are the latest thing in radio astronomy. The bigger a



Australia needs more big radio telescopes, but the government's budget will decide whether it gets them

radio telescope, the more detail it can "see". But a radio telescope that could resolve details as fine as those revealed by optical telescopes would have to be several kilometres in diameter. This is physically impossible, but electronically possible. What radio astronomers do is to connect electronically several small radio telescopes hundreds or even thousands of kilometres apart. The resulting array of radio telescopes can see details finer than those observed through any other kind of telescope.

Brian Lee, Canberra

If Australian astronomers fall behind in either discipline, they cannot expect to remain at the forefront of astronomy for long. The discovery in March of quasar PKS 2000-300, the most distant object yet seen in the universe (and arguably the most important astronomical discovery in recent years) involved the cooperation of radio astronomers and optical astronomers. This discovery ended a 10-year drought in the finding of ever more distant celestial bodies, and it will allow astronomers to break through the mental barrier raised by the widely held feeling that they had already seen the edge of the universe.

The quasar's discoverers included Bruce Peterson at ANU, Anne Savage of the Royal Observatory of Edinburgh, and David Jauncey and Alan Wright of CSIRO. To prove the existence of the quasar, they had to detect it using CSIRO's 21-year-old 64-metre radio telescope at Parkes in New South Wales. Then they had to use the US-Australian array of radio telescopes at Tidbinbilla near Canberra to place accurately; the Royal Observatory of Edinburgh's UK Schmidt Telescope at Siding Spring to identify it as an optical object; and the Anglo-Australian Telescope to obtain its optical spectrum.

Australian astronomers see Starlab and the Australian Telescope as essential if they are to maintain this pace.

If agreed, Australian participation in the retrievable Starlab will be a great coup for Don Mathewson, the ANU's Professor of Astronomy and Director of the Mount Stromlo and Siding Spring Observatory. He will have managed to project Australian astronomy into space for a modest \$25.5 million. At the moment, NASA plans to put Starlab on the space platform the space shuttle will launch in 1989. About 10 missions, each lasting 6-12 months, are planned.

NASA has agreed to provide the platform and the first two launches at no cost to Canada and Australia. Canada will build the telescope and Aus-

tralia will provide the instrument package, consisting of a camera, a spectrograph, electronic equipment for recording ultraviolet images, and equipment for telemetering information to Earth. Canada and Australia will share the \$51-million cost of the telescope and instrument package equally.

Mathewson's trump card has been his group's lead in the development of equipment for recording ultraviolet images—equipment which (according to Ed Weller, Chief of Astronomy at NASA) puts the Australians two years ahead of their rivals. Without this equipment the telescope cannot succeed.

None of the three participating governments will have to commit themselves finally to Starlab until January 1984. But the Canadians have already committed money up to that date for design studies of the telescope and the Australian government must provide \$1.8 million this coming financial year to pay for detailed design studies for the instrument package. Its refusal last year to provide \$104 000 for design studies was not fatal to the project: 14 local companies enthusiastically came to the rescue. But in spite of their enthusiasm for the project, the companies will not support it much longer without a commitment to additional support from the government.

The Australian Telescope should be completed in 1988, Australia's bicentenary year. Like Starlab, it will cost the government about \$25 million, but spending on the project will peak about two years earlier in 1985. CSIRO will build the instrument along a 300-kilometre, north-south axis in New South Wales by linking the 64-metre Parkes telescope to a new 22-metre dish 200 km further north at Siding Spring, and to a 6-km, east-west linear array of five, 22-metre dishes at Culgoora, a further 100 km north again. □

Only the rich become richer in space

Keep weapons out of space and give us a fair share of the benefits, says the Third World.

The super powers seem to have other ideas

AN ELDERLY VIENNESE dressed in a Roman toga and clasp a sign saying "Peace", has done his best to prick the conscience of the world's super powers about the escalating arms race in outer space. The Austrian eccentric has hung about the outside of the conference hall in Vienna which, for the past ten days, has hosted a United Nations conference on the applications of resources beyond the Earth's atmosphere (Unispac).

A clutch of keen-eyed policemen and security officials have not allowed the one-man demonstration inside the building. But, in the opinion of some representatives at the conference, the same treatment should have applied to the issue of peace itself.

James Beggs, administrator of NASA and head of the American delegation, says that the issue of arms in outer space is "too complex" to intrude into the constitutional niceties of the gathering. He would prefer to see other United Nations bodies, for instance those concerned with disarmament, discuss the matter. And Kenneth Baker, Britain's minister for information technology, summed up the views of much of the rest of the industrialised world. He told *New Scientist* that, although concerned about arms in outer space, he would not want to raise the issue publicly at an international conference.

But Javier Perez de Cuellar, Secretary General of the United Nations set the tone for much of the rest of the proceedings when, in his opening statement, he spoke out against the deployment of weapons in space. Apart from moral considerations, he said, research into weaponry diverts resources away from work that could benefit mankind, particularly nations in the less developed world.

Representatives from the Third World have risen one by one to follow the lead of the UN statesman. Domingo Siazon, the Philippine Ambassador to Austria, reminded the conference that only two nations, the US and the USSR, have demonstrated that they can station weapons in orbit. But he warned that the world could still witness an increase in the number of countries with these powers that could match the growth in the past 20 years of nations with nuclear weapons.

While the US has completely ignored the issue, the Soviet Union has made some moves in favour of what the Third World wants, a ban on any weaponry in space. Such a measure would supplement the 1967 Outer Space Treaty of the United Nations. This forbids any nation to put into orbit nuclear weapons as well as "devices of mass destruction". Crucially, the wording does not prohibit the launching of anti-satellite devices or

Peter Marsh, Vienna

laser weapons, the chief examples of the fearsome space hardware that is at the heart of Soviet and American experiments.

In his contribution, Vladimir Kotelnikov, vice president of the USSR Academy of Sciences and head of the Soviet delegation, said, "Space should be peaceful and only peaceful". He said the Soviet Union has already submitted to the United Nations a draft of an agreement that would stop further militarisation in space.

To supervise such an agreement, if and when it is made, many of the countries in the Third World want to tighten up the United Nations mechanisms that deal with space. The most radical suggestion has come from Pakistan which wants an international space agency with headquarters possibly in Geneva or Vienna. Besides monitoring encroachments upon space for military purposes, the agency would also oversee other matters that divide the industrialised and developing world.

Of these, the most crucial concerns remote sensing of the Earth by satellite. The developing nations want some kind of global body to oversee remote sensing so that all countries can gain access to data from the craft. This information can give vital details about the growth of crops or the sites of valuable mineral deposits.

At present, the US runs a remote sensing system based on two Landsat

satellites that "see" virtually every area of the world from altitudes of several hundred kilometres. In the next few years, France, Japan, India and the nations of the European Space Agency will organise similar systems to sell data to the rest of the world. But Jing Zhaoquan of China's Ministry of Space Technology points out that the developing countries have no guarantees that the data will continue to be freely available. Another fear is that if a private firm from the developed world with access to the satellite information spots, for instance, a source of minerals in a developing country, it might keep the data to itself and go on to prospect the area without involving the nation concerned.

Yash Pal, an Indian space scientist who is secretary general of the conference, says, "The Third World must not be forced to rely on the good will of the industrialised nations for this kind of data."

The international space agency would cost about \$10 million per year to run, says Salim Mehmood, the head of the Pakistan delegation. This would be on top of the cost of launching its own satellites, if these were needed. An alternative, says Mehmood, would be to take over existing remote sensing craft such as Landsat.

Another role for the world space agency could be to share out slots in geostationary orbit 36 000 km above the Earth—the most popular position for communications satellites. Nations from



An international space agency might guarantee satellite data for crop growers

Whose orbit is it anyway?

THE WORLD'S SPACE POWERS are blaming each other for not co-operating in manned space projects. Both the US and the USSR have concentrated on programmes for putting people into space, the US with its space shuttle, and the Soviets with a series of flights to the Salyut 7 space station now in orbit. But the only time the nations have collaborated was in one joint flight seven years ago.

James Beggs, the administrator of NASA, says that the US does not plan to cooperate with the Soviets "until they behave themselves" on a wider political front. He explained that he was referring to events in Poland and Afghanistan.

By contrast, says Beggs, the United States has been "pure and pristine". He went on: "We have not invaded any countries lately". The joint project in 1975 was, says Beggs, "like pulling

teeth" for the Americans because of the great difficulty in persuading the Soviet Union to disclose technical details about their spacecraft. "Despite this we would have been ready to plan joint missions if conditions in the rest of the world were more normal."

Beggs adds that the US would be willing to take into orbit astronauts from the Third World and other nations with whom the US participates in space missions. For instance, if NASA signs a deal with a particular country to launch a satellite, then the agency will consider taking into space a scientist from that country to handle the satellite.

For its part, the Soviet Union has criticised the US for stopping joint programmes. Speaking at the Unispace conference last week, Vladimir Kotelnikov, head of the country's delegation, said it was regrettable that the co-

operation ended. "But it is not the Soviet side which is to blame."

Oleg Garenko, another member of the delegation, said that the Soviet Union would probably launch two more flights this year to the Salyut 7 space station which recently went into orbit. The next station, Salyut 8, will be launched in about two or three years, said Garenko who is director of the Soviet Institute for Medical and Biological Problems. This will be similar to Salyut 7 but will have extra modules to increase available room.

Garenko was speaking at a reception in Vienna at which the Soviets paraded no fewer than eight cosmonauts, including six from nations that have participated in space flights as part of the Interkosmos programme. By contrast, the US party included just one astronaut, Herty Hertfeldt who flew on the shuttle's last trip. □

the Third World are worried that the International Telecommunication Union, another agency of the United Nations, has allocated these slots on a basis of "first come, first served". This means that the developed world has already used up most of the slots, with few left for other countries if and when they develop their own spacecraft.

Mehmood, who is chairman of Pakistan's Space and Upper Atmosphere Research Commission, stresses that he does not want to press gang the developed world into giving up its dominant position in space. "The very fact that so many nations with such powerful delegations are at this conference contributes to international understanding. I would like to see a step in the direction of an international agency. What is required is a change of attitude and a change of mind."

Representatives from the developed world are unenthusiastic about Pakistan's proposals upon which, as with all the other matters of controversy, the conference should have reached broad agreement by the time it ends on Saturday (21 August). "We have found that United Nations mechanisms in the area of exploitation of technology have not been effective," says James Beggs of NASA.

A member of another western delegation was more blunt. Discussing the draft report of the conference, which the gathering is discussing clause by clause until a common view can be formulated, he said, "It is full of the same old plays from the developing countries. They want to get the benefits of technology without having to pay for them."

For Britain's part, Baker says he will not support the establishment of new international agencies simply because it would cost too much.

India, one of the developing nations that is spending a lot on space technology, also does not agree with Pakistan's proposal. Eknath Chitnis the director of the Space Applications Centre run by the Indian Space Research Organisation in Ahmedabad, says he



Landsat D—for whose benefit?

would prefer to see more agreements between countries organised on a regional, rather than a global, basis. For instance, he is interested in participating with near neighbours such as Pakistan, Sri Lanka and Bangladesh on joint satellite projects.

India is repeatedly leaving the camp of the "have nots" in space technology. It has launched two satellites with its own rockets and from earlier this year has operated a national communications satellite for TV broadcasting and telephone calls.

The United States has been keen to offer the Third World a few crumbs of comfort. Beggs announced at the conference that the US wants to start a long term study into what he calls "global habitability".

The US has issued a glossy brochure on this subject and even devoted a fair chunk of an official American gala evening—which featured novelist James Michener extolling the virtues of the space shuttle—to talk about what it means. Yet all the signs are that "global habitability" is no more than a variation on that vague phrase of the 1970s, "the environment".

The details of the study are still to be

worked out, Beggs told *New Scientist*. But over 10 to 20 years he wants to mount research, in collaboration with other countries where possible, into the factors that affect the atmosphere and the Earth. This would encompass work on pollution, the ozone layer, the impact of the increasing volume of carbon dioxide in the atmosphere, as well as mapping of the oceans and areas such as forests.

According to Beggs, NASA already devotes about half of its annual science budget of \$1000 million dollars to this kind of activity. He does not necessarily envisage more spending, more a reorientation of work to dovetail with other countries.

The study would use data from remote sensing satellites and could involve the launch of new craft expressly for this purpose. It would probably also link with the United Nations World Meteorological Organisation, which already runs what it calls the World Weather Watch. This is a system of satellites, each owned by individual nations, which as a result of informal agreements provide a continuous stream of data about what is happening in the upper atmosphere.

According to one worker with the WMO, the World Weather Watch "is a fantastic way of getting nations to work together without setting up a big machine". It is undoubtedly this lack of bureaucracy which makes Beggs warm to the new study no matter how many other nations enter the scheme. NASA officials in Washington would be firmly in control. There would be no messy system of United Nations committees to encounter.

Meanwhile, nations from the Third World have to decide what the scheme means to them. In the opinion of one space scientist from India, the study is attractive and will offer real benefits. But other nations are likely to lean towards the view that "global habitability" is a sop that distracts attention from efforts to obtain a mechanism for regulating the world's space affairs in which everyone has an equal say. □

Consciousness: a just-so story

I am conscious, and you probably are too. But why? What biological function does this remarkable ability subserve?

Nicholas Humphrey Biologists who have thought, but not thought enough, about consciousness will be found toying with two contradictory ideas. First—the legacy of the positivist tradition in philosophy—that consciousness is an essentially private thing, which enriches the spirit but makes no material difference to the flesh, and whose existence either in man or other animals cannot in principle be confirmed by the objective tools of science. Second—the legacy of evolutionary biology—that consciousness is an adaptive trait, which has evolved by natural selection because it confers some (as yet unspecified) advantage on those individuals who possess it.

Put in this way, the contradiction is apparent. Biological advantage means an increased ability to stay alive and reproduce; it exists, if it exists at all, in the public domain. Anything which confers this kind of advantage—still more, anything whose evolution has specifically depended on it—cannot therefore remain wholly private. If consciousness is wholly private it cannot have evolved. Or if it has evolved, it must in Hamlet's words be but private north-north-west; when the wind is southerly it must be having public consequences. If the blind forces of natural selection have been able in the past to get a purchase on these consciousnesses, so now should a far-seeing science.

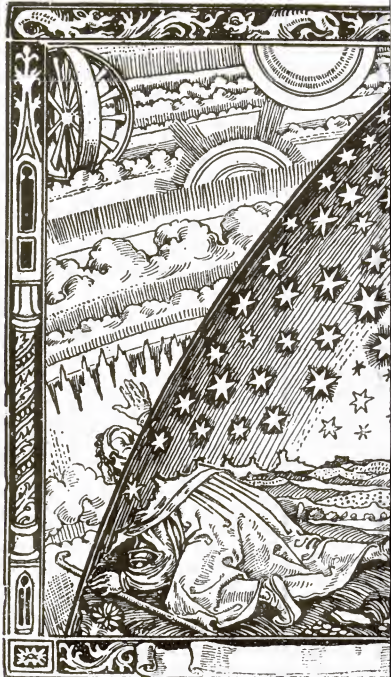
Yet scholars will, I suspect, continue to tolerate the contradiction, paying lip service both to the privacy and to the evolutionary adaptiveness of consciousness, until they are offered a plausible account of just wherein the biological advantage lies. At present, so far from having a testable hypothesis which we could apply to species other than our own, we lack even the bones of a good story about consciousness in human beings. I here present one: a Just-So story.

But first some pointers to what, in the context of this story, I take "consciousness" to mean. I rely on there already being between us the basis for a common understanding. I assume that you yourself are another conscious human being; that you have a personal conception of what consciousness is like; that you have experienced, waking and sleeping, both its presence and its absence; and that having noticed the contrasts you have already formed some notion of what consciousness is for. I assume moreover that although you may never have had occasion to pronounce on it, you will not find it difficult to recognise someone else's pronouncements (mine, below) as true to your own case.

Provided, that is, you are in fact a conscious human being, and not as it happens an unconscious robot or a philosopher from Mars. Provided, also, that you have not been too much influenced by Ludwig Wittgenstein. When Wittgenstein in his *Philosophical Investigations*, alluded to consciousness as a "beetle" in a box—"No one can look into anyone else's box, and everyone says he knows what a beetle is only by looking at his beetle... Everyone might have something different in his box... The box might even be empty"—he chose the name of a thing which has no obvious use to us, and thereby implicitly ruled out the possibility that the things in our several boxes might bear a functional resemblance to each other. But suppose the thing in the box had been called, let's say, a "pair of scissors". One person's pair of scissors might indeed look rather different from another's: long scissors, short scissors,

scissors made of brass or steel. But scissors, to be scissors, have to cut. There is really no danger that what we both agree to call a "pair of scissors" could in my case be a jelly-baby while in your case is empty air.

From all I know about myself, what strikes me—and seems to give some kind of cutting edge to consciousness



—is this. The behaviour of human beings, myself included, is in every case under the control of an internal nervous mechanism. This mechanism is responsive to and engaged with the external environment but at the same time operates in many ways autonomously, collating information, hatching plans, and making decisions between one course of action and another. Being internal and auto-

mous it also, for the most part, operates away from other people's view. You cannot see directly into my mechanism, and I cannot see directly into yours. Yet, in so far as I am conscious, I can see as if with an inner eye into my own.

During most of my waking life I have been aware that my own behaviour is accompanied by certain conscious feelings—sensations, moods, desires, volitions and so on—which together form the structure and content of my conscious mind. So regular indeed is this accompaniment, so rarely does anything happen to me without its being either preceded or paralleled by the experience of a conscious feeling, that I have long ago come to regard my conscious mind as the very same thing as the internal

its smell."

Thus consciousness (some would say "self-consciousness", though what other kind of consciousness there is I do not know) provides me with an explanatory model, a way of making sense of my behaviour in terms which I could in no way otherwise devise. And to the extent that it is successful, it is successful presumably because the workings of my conscious mind do in reality bear some kind of formal (if limited) correspondence to the workings of my brain. "Hunger" corresponds to a state of my brain; "wishing" corresponds to a state of my brain; even the organising principle of consciousness, my concept of my "self", corresponds to an organising principle of brain states. Not that physiologists have yet come up with an analysis of brain activity along these lines. But that, for the moment, is their problem, not mine. As a child of the evolutionary process, whose ancestors have been in this business for many millions of years, I am, in relation to my own behaviour like the ancient astronomer in the picture, who has found a way of looking in directly on the wheels and cogs which move the stars across the heavens: the stars are my behaviour, the cogwheels are the mechanism which controls it, and the astronomer peering in on them is I myself.

So what?

Percipient but not conscious

So, once upon a time there were animals ancestral to man who were not conscious. That is not to say that these animals lacked brains. They were no doubt percipient, intelligent, complexly motivated creatures, whose internal control mechanisms were in many respects the equals of our own. But it is to say that they had no way of looking in upon the mechanism. They had clever brains, but blank minds. Their brains would receive and process information from their sense organs without their minds being conscious of any accompanying sensation; their brains would be moved by, say, hunger or fear without their minds being conscious of any accompanying emotion; their brains would undertake voluntary actions without their minds being conscious of any accompanying volition... And so these ancestral animals went about their lives, deeply ignorant of an inner explanation for their own behaviour.

To our way of thinking such ignorance has to be strange. We have experienced so often the connection between conscious feelings and behaviour, grown so used to the notion that our feelings are the causes of our actions, that it is hard to imagine that in the absence of feelings behaviour could carry on at all. It is true that in rare cases human beings may show a quite unexpected competence to do things without being conscious of their inner reasons: the case, for example, of "blind-sight", where a patient with damaged visual centres in the brain can point to a light without being conscious of any sensation accompanying his seeing (and without, as he says, knowing how he does it). But the patient himself in such a case confesses himself baffled; and you and I will not pretend that that would not be our reaction too.

Such bafflement, however, was one among the many things our unconscious ancestors were spared. Having never in their lives known inner reasons for their actions, they would not have missed them when they were not there. And whether we can imagine it or not, we should assume that, for the life-style to which they were adapted, "unconsciousness" was no great handicap. With these animals it was their behaviour itself, not their capacity to give an inner explanation of it, that mattered to their biological survival. As the occasion demanded they acted hungry, acted fearful, acted wishful and so on, and they were none the worse off for not having the feelings which might have told them why.



Mary Evans

mechanism which controls my bodily behaviour. If I ask myself *why* I am doing something, like as not my answer will be framed in conscious mental terms: I am doing it because I am aware of this or that going on inside me. "Why am I looking in the larder? Because I'm feeling hungry... Why am I raising my right arm? Because I wish to... Why am I sniffing this rose? Because I like

Nonetheless, these animals were the ancestors of modern human beings. They were coming our way. Though their lives may once have been comparatively brutish and relatively short, as generations passed they began to live longer, their life-histories grew more complicated, and their relationships with other members of their species became more dependent, more intimate, and at the same time more unsure. Sooner or later the capacity to explain themselves and to explain others—to take on, if it's not too grand a word, the role of a natural "psychologist", capable of understanding and predicting their own and others' behaviour within the social group—would become something they could no longer do without. At that stage would not their lack of consciousness have begun to tell against them?

Watch your brain working

Not necessarily. At least not at first, and not to the extent that all that's said above implies. For inner explanations are not the only kind of explanations of behaviour. Debarred as our unconscious ancestors may have been from looking in directly on the workings of their brains, they could still have observed behaviour from outside: they could have observed what went into the internal mechanism and what came out, and so have pieced together an external, objectively based explanatory model. "Why am I (Humphrey) looking in the larder?" Not, maybe, "Because I'm feeling hungry", but rather "Because it's five hours since Humphrey last had anything to eat" or "Because Humphrey has shown himself to be less fidgety after a snack".

In short, while our ancestors lacked the capacity to explain themselves by "introspection", there was nothing to stop them doing it by the methods of "behaviourism". "The behaviourist," wrote one of its first modern champions, J. B. Watson, "sweeps aside all medieval conceptions. He drops from his scientific vocabulary all subjective terms such as sensation, perception, image, desire, purpose, and even thinking and emotion." And who better placed to follow this recommendation than an unconscious creature for whom such conceptions could not have been further from his mind? In fact, it is we conscious human beings who have trouble being hard-headed behaviourists: it is *we* who, as that other great behaviourist B. F. Skinner has lamented, "seem to have a kind of inside information about our behaviour. We have feelings about it. And what a diversion they have proved to be! . . . Feelings have proved to be one of the most fascinating attractions along the path of dalliance."

Why, then, when ignorance of the inner reasons for behaviour might have been bliss, did human beings ever become wise? Adam, the behavioural scientist, might with Newtonian detachment have simply sat back and watched the apple fall; but, no, he ate it.

What tempted him was a leap in the complexity of social interaction, calling in its turn for a leap in the psychological understanding of oneself and others. Suddenly the old-time psychology which was good enough for our unconscious ancestors, which is still apparently good enough for Watson and for Skinner, was no longer good enough for their descendants. Behaviourism could take a natural psychologist only so far. And human beings were destined to go further.

At what point the threshold was crossed we cannot tell. But there is evidence that by three or four million years ago, and possibly much earlier, our ancestors had already embarked on what was in effect a new experiment in social living. Leaving behind the relatively dull life of their ape-like forebears—leaving behind their thick skins, large teeth and heavy bones, leaving behind their habitation in the forest and their hand-to-mouth existence as vegetarian gypsies—they sought this new life as hunter-gatherers on

the African savanna. They sought it with stone tools, they sought it with fire; they pursued it with forks and hope. But above all, they sought it through the company of others of their kind. For it was membership of a cooperative social group which made the life of hunting and gathering on the plains a viable alternative to what had gone before. Life from now on was to be founded on collaboration, centred on a home base and a place in the community. This community of familiar souls would provide the context in which individuals could reap the rewards of cooperative enterprise, where they could benefit from mutual exchange of materials and ideas, and where (against all subsequent advice) they could become borrowers and lenders and then borrowers again—borrowers of time, of care, of goods and services. But most important, the community would provide them as they grew up first with a nursery and then with a kind of polytechnic school where they could learn from others the practical techniques on which the life of the hunter-gatherer depended.

But the intense social engagement which this new life style entailed spelt trouble. For human beings would not, overnight, abandon self-interest in favour of the common good. And while it is true that each individual stood to gain by preserving the social system as a whole, each continued also to have his own particular loyalties; to himself, to his kin and to his friends. A society based, as this was, on an unprecedented degree of interdependency, reciprocity and trust, was also a society which offered unprecedented opportunities for an individual to manoeuvre and outmanoeuvre others in the group.

Thus the scene was set for a long-running drama of personal and political intrigue. Men and women were headed to become actors in a human comedy, played out upon the flinty apron stage which formed their common home. It was a comedy which would be tragedy for some. It was a play of ambitions, jealousies, loves, hates, spites and charities, where success meant success in the conduct of personal relationships. And when the curtain fell it was to those who, as natural psychologists, had shown the greatest insight into human nature that natural selection would give the biggest hand.

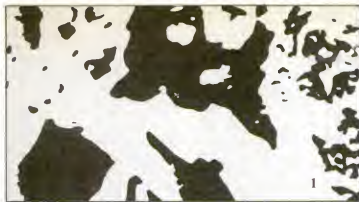
Imagine now two different kinds of player, with very different casts of mind. One the traditional unconscious behaviourist, who based his psychology entirely upon external observation; the other a new breed of introspectionist, who took the short cut of looking directly in upon the workings of his brain.

The behaviourist search for patterns

The behaviourist starts with a blank slate. In the manner familiar to those of us who have followed the progress of behaviourism as a modern science, he patiently collects evidence about what he sees happening to himself and other people, he correlates "stimuli" and "responses", he looks for "contingencies of reinforcement", he tries to infer the existence of "intervening variables" . . . and thus, without prejudice, he searches for a pattern in it all.

This programme for doing psychology is not, let it be said, a hopeless one. It must have sufficed for our unconscious ancestors for many million years. It probably still suffices for most if not all non-human social animals alive today. With a bit of luck it might have sufficed for those who began to live the life of social human beings, had they but world enough and time, had there been no one else around with the gift of doing the job much better.

But now there was someone else around, and world, time and luck were all at once in short supply. An introspectionist had entered on the scene: someone who starts with a slate on which the explanatory pattern is already half sketched in. From earliest childhood the introspectionist has had the opportunity to observe the causal

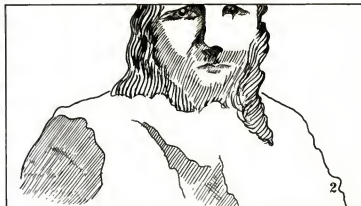


structure of his own behaviour emerging in full inner view: he has sensed the connection between stimulus and response, he has felt the positive and negative effects of reinforcement, he has been directly appraised of the intervening variables, and he has daily experienced the unifying presence of his conscious self.

In the first instance, certainly, the introspectionist's explanatory model applies only to his own behaviour not to others'. But once, in his own case, a pattern of connections has been forced on his attention, the idea of that pattern will dominate his perception in other cases where the connections are not openly on show. Once, in his own case, an outer effect has been seen to have an obvious inner cause, the idea of that cause will help him to make sense of situations where the effect alone can be observed. Cover the face in Figure 1, and try not to imagine the face in Figure 2. Notice that a fire in your own private hearth causes smoke to issue from your chimney, and try not to imagine that the smoke coming from the house across the road implies the presence of a fire within.

Thus the introspectionist's privileged picture of the inner reasons for his own behaviour is one which he will immediately and naturally project on other people. He can and will use his own experience to get inside other people's skins. And since the chances are that he himself is not in reality untypical of human beings in general — since the chances are that, just as from house to house there is generally no smoke without fire, so from person to person there is generally no looking in the larder without hunger, no running away without fear, no rage without anger, etc — this kind of imaginative projection gives him an explanatory scheme of remarkable generality and power.

Thomas Hobbes in the *Leviathan* made the point, as few philosophers since then have dared to ([Assuming on] the similitude of the thoughts and passions of one man to the thoughts and passions of another, whosoever looketh into himself, and considereth what



he doth, when he does think, opine, reason, hope, fear &c and upon what grounds he shall thereby read and know what are the thoughts and passions of all other men upon the like occasions."

Let us return then to the age old human play. Scattered among the population of unconscious behaviourists, there arose in time these conscious prodigies. Soon enough an unconscious Watson would find himself up against a conscious Iago, an unconscious Skinner would find himself laying suit to a conscious Portia . . . Natural selection was there to supervise their exits and their entrances.

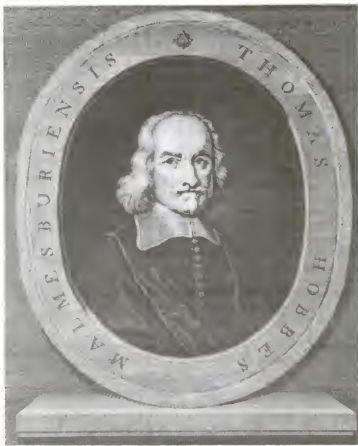
It was clear where the story for the human species had to end.

But for the rest of the animal kingdom? As the bias of my story must have shown, I am not convinced that any other species has followed the same path to consciousness as man. But studies of the social systems of other species are not far advanced, and studies of how individual animals themselves do their psychology have hardly begun. It may yet turn out that there are, in fact, non-human

species whose social systems rival the complexity of man's; it may yet turn out that individuals of those species are, in fact, making use of explanatory systems which bear the hallmarks of a mind capable of looking in upon the inner workings of the brain. Stories have been wrong before. The cat, we know, does not walk by itself. But the rhino? Nothing suggests that the rhino gets inside another rhino's skin.

Meanwhile, for the obvious candidates — the social carnivores, the great apes — there will be biologists who in fairness want to leave the question undecided. Undecided, but not undecidable. In medieval England a jury could bring in four alternative verdicts at a trial: Guilty, Not Guilty, *Ignoramus* (we do not know), *Ignorabimus* (we shall not know).

"*Ignorabimus*" would be a counsel of philosophical despair. "*Ignoramus*" is the proper verdict for biologists. For if consciousness has evolved we shall know it by its works. □



Thomas Hobbes: "whosoever looketh into himself shall know the thoughts and passion of all other men"

Mary Evans

The skies of Babylon

Ancient Babylonian astronomers carefully recorded the motions of the Sun, Moon and planets, and took special note of eclipses. Their records are proving invaluable to both astronomers and geophysicists

Richard Stephenson Astronomical research today often seems to require the latest in technological hardware, whether it is a new electronic light detector or an X-ray observatory in Earth-orbit. Yet astronomy, the most futuristic of sciences, is also the science which can draw most benefit from the thousands of years of past records which have come down to us from past civilisations. Ancient astronomers recorded what has actually happened in the sky, and where and when particular events like eclipses could be seen. Some of the most useful observations come from the Babylonians, authors of the great civilisation which flourished in what is now Iraq during the last two millennia BC.

The Babylonians were the astronomers *par excellence* of the ancient Near East. Yet until a century ago we knew very little about their preoccupation with stargazing, and that knowledge was gleaned entirely from secondhand sources. Several Greek and Roman works, as well as the Old Testament, give us a rather sketchy outline, and show a definite emphasis on astrology rather than "scientific" astronomy. The great Greek-Egyptian astronomer Claudius Ptolemy hinted at the scale on which astronomy was practised in Babylon. Writing in the 2nd century AD, he stated that he had access to almost complete observations of eclipses going back to the reign of Nabonassar (747 BC). However, in his *Mathematiké Syntaxis* (better known now as the *Almagest*), Ptolemy cites only about half a dozen actual examples. This brief list was to remain the sum total of preserved Babylonian observations for more than 1700 years.

Recently-excavated Babylonian texts indicate that after many centuries of systematic observation, the pursuit of astronomy died out in Babylon towards the end of the 1st century AD. This interpretation fits in well with the gradual decay of Babylonian civilisation, as related by the classical Greek and Roman writers. Alexander the Great captured Babylon in 331 BC, and the city entered its "Hellenic" (Greek) period. But Babylon soon afterwards suffered a disastrous blow from which it never recovered: around 275 BC, much of the population was forcibly transferred to the newly founded capital city of Seleucia. A little more than two centuries later, Diodorus Siculus reported that Babylon had largely become a ruin. Only a small part of the city was inhabited; the remainder being given over to agriculture. This theme of degeneration was echoed by the geographer Strabo, who in 24 AC remarked that "the great city is a great desert". When the Roman Emperor Trajan win-



Alan McCune

First sight of crescent Moon was a major event each month

tered there in AD 116 he found nothing except ruins. Not long afterwards, Babylon had become a lost city. It was not rediscovered until the 18th century.

Practically all our present knowledge of Babylonian astronomy has come from the discovery and decipherment of cuneiform texts—Babylonian "writing" in the form of groups of narrow triangles carved on stone or impressed into clay tablets. The Neapolitan traveller Pietro della Valle stimulated interest in cuneiform inscriptions when he visited the ruins of Persepolis in the early 17th century. He studied some of the groups of wedges carved on pillars, and sent copies back to Europe. Georg Grotefend, a German high school teacher, took the first steps

in deciphering this writing. In 1802 he accepted a dare from a friend, and managed to uncover the meaning of several signs. A few decades later, British diplomat Sir Henry Rawlinson achieved spectacular success in interpreting the Babylonian symbols, aided by his extensive knowledge of modern Persian. By the 1850s, cuneiform studies had become a mature discipline.

The first cuneiform texts containing astronomical information began to be found in the 1870s. The discovery was completely accidental. Gangs of workmen, pillaging the ruins of Babylon for bricks to re-use in modern construction, unearthed large numbers of clay tablets. Some of these tablets found their way to antique dealers in nearby Baghdad, where they were largely bought by the British Museum. Only a very few texts were ever purposely excavated.

Experts believe that only about 5 per cent of the original material has so far been accounted for. We do not know whether the rest was destroyed or if some has still to come to light. Practically all of the extant astronomical tablets — some 1500 in all — are now in the British Museum: only a few tens are elsewhere. They are generally broken into fragments, and because of this less than half the tablets have so far been dated. Translations of only a few selected texts have been published and very few have heard of them.

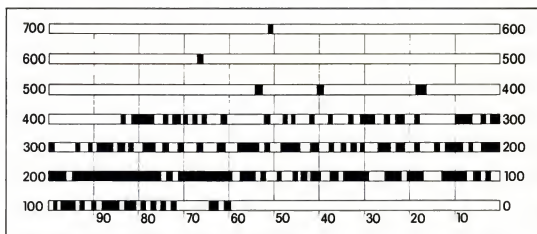
With a few notable exceptions, the texts which can be dated are all fairly late, after 750 BC. The earliest material (which in fact exists only in the form of later copies) relates to the first and last calendar dates when Venus was visible, in each appearance of the planet. These observations cover the reign of a single king, Ammisaduqa, who probably reigned about 1700 BC. As yet, we have not been able to establish the actual dates by comparing the record with calculations of Venus's appearances around that time, partly because of scribal errors which sometimes produce impossible figures.

After the Venus tablets of Ammisaduqa, there are no

further Babylonian astronomical observations of any kind until the 8th century bc. The gap ends with a tablet that probably dates from 747-45 bc, which records details of consecutive lunar eclipses over three years, which is probably the period 747-45 bc. This tablet would then be the earliest known astronomical text from the later period, corresponding to the first three years of the reign of Nabonassar. Another tablet, this time bearing a well-preserved date, reports an attempt to make a prediction of a lunar eclipse in the first year of Nabu-mukin-zeri (731 bc). This particular eclipse failed to happen. Increasing numbers of texts are extant from 700 bc onwards, right up to the very latest known Babylonian

months was thus only 354 days long, falling some way short of the true solar year. Every two or three years, the Babylonians had to insert an extra month to keep their calendar roughly in step with the seasons. Until the beginning of the reign of Seleucus I (311 bc), the Babylonians counted years from the accession of each ruler, so there was no continuous count of years. This was a common practice in the ancient world, and has frustrated present-day historians. The successors of Seleucus I continued to use the start of his reign as their reference. In fact, some parts of Western Asia still count years from the Seleucid Era, for example in Syrian-speaking churches in Iraq and Coptic churches in

In this graph covering the last seven centuries bc, a black bar shows that at least one fragment of Babylonian tablet has survived from that year. The dates start at -700 (701 bc) at top left, and run in the seven lines up to the year 0 (1 bc). We have fragments from more than 180 different years, but the total time covered adds up to only a few decades. The graph is part the fruits of research by A. J. Sachs (Philosophical Transactions of the Royal Society Series A, vol 276, p 43)



A. J. Sachs/Royal Society

observations in 41 bc. However, we have several later almanacs, predicting planetary positions, right down to AD 75. Regular astronomical observations probably continued to this date.

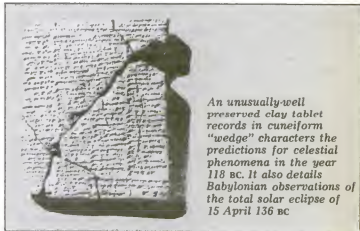
From the later texts, experts have built up a fairly detailed picture of Babylonian astronomy. Over the seven centuries or so covered by the surviving tablets, we find a gradual evolution in both the accuracy and regularity of observation. However, we have no means of tracing the early history of astronomy in Babylon. There is a tradition dating from the Hellenistic period that King Nabonassar (like Emperor Ch'in Shih-huang in China) destroyed the historical records of his predecessors. Whether this is true or not, the few surviving texts from the 8th century bc reveal an already fairly advanced level of both skill and organisation. Just how many centuries this took to develop we cannot say.

The Late Babylonian (later than 747 bc) observational texts fall into three main categories. The most numerous tablets are astronomical diaries which contain a month by month record of all kinds of observation. Two other classes of text contain material abstracted from the diaries, and these date mainly from the Hellenistic period. This material was clearly to be used for predicting the future positions of the planets. The second category consists of the many tablets devoted to lists of specific types of observation. These contain sightings of particular planets or lunar phenomena such as eclipses. Goal-year texts, which give a direct insight into methods of prediction practised by the Babylonians, form the third category. To predict the astronomical phenomena for a given year, they combined data on the eclipses of 18 years before with those on the movements of Venus made eight years previously, and so on for the other planets.

Before discussing the content of the observational texts in detail, it is important to discuss the form of the Babylonian calendar, as revealed by these same tablets. The Babylonian calendar was luni-solar: it marked time by actual lunar months, the interval of about 29½ days from new Moon to new Moon. The year of 12

various parts of Egypt.

The Babylonian new year began on the first day of the month Nisanu, and it was always in the spring, corresponding to our March-April. The addition of an intercalary month every two or three years to keep Nisanu in the spring season was at first done rather haphazardly, although the additional month always followed Ululu (the 6th month) or Addaru (12th month). Early in the 4th century bc, a 19-year cycle (also in use in Greece) came into use for calendar regulation. Nineteen is the smallest whole number of years for which the total number of days is the same as the number of days in an integral number of months. The agreement is fortuitous, but very good. The interval between one spring equinox and the next is called a tropical year; and 19 tropical years is 6939.60 days. This is very close



An unusually well preserved clay tablet records in cuneiform "wedge" characters the predictions for celestial phenomena in the year 118 bc. It also details Babylonian observations of the total solar eclipse of 15 April 136 bc

to exactly 235 lunar months which comes to 6939.69 days. As 19 years of 12 lunar months contain 228 months, the Babylonians had to insert seven extra months in every 19 year period.

From earliest times, the Babylonians began each month

with the first visibility of the young crescent Moon in the evening sky, as in the Islamic calendar today (*New Scientist*, vol 94, p 854). In the first few centuries of the period covered by the texts it seems likely that a watch was kept for the crescent at the close of the 29th day. If observers saw the Moon, then the new month began immediately. However, if the crescent was not visible for any reason (including unfavourable weather) then the new month began the following evening. Hence months lasted either 29 or 30 days, and were called "hollow" or "full" respectively. During the Hellenistic period the astronomers developed some sort of empirical

intervals immediately after full Moon; timing lunar eclipses when they occurred and estimating the fraction of the Moon covered at greatest phase; and timing close approaches of the Moon to the planets and to some 30 *ziqu* or reference stars and estimating the angular separation at closest approach. In the case of the planets, the Babylonian astronomers recorded dates of heliacal rising or setting (when a planet draws near to the Sun and disappears from view, and when it first reappears separate in the morning sky from the Sun) as well as conjunctions with these same *ziqu* stars.

There are also some non-astronomical phenomena re-

The cuneiform tablet records the first visibility of the crescent Moon every month; pictured below is one of the narrowest Moon crescents photographed, taken only 21½ hours after new Moon. Babylonian astronomers used these observations to keep their calendar which was based on lunar months



William D. Pence

rule for predicting whether the crescent should have been visible. Apparently this was used for deciding the length of the month when cloud or severe mist prevailed on the 29th day. Modern calculation shows that on these occasions they did predict the visibility of the crescent rather accurately.

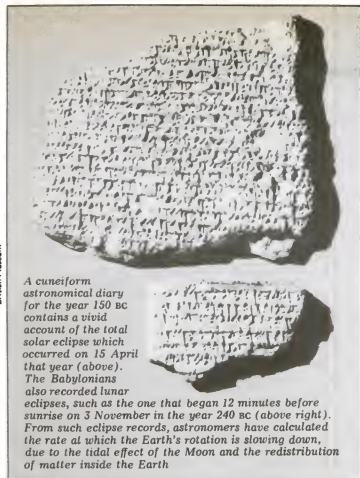
A typical Babylonian diary reports astronomical observations in a fairly well-defined pattern. The emphasis was quite definitely on the Moon and the planets; and the main motive was to improve the prediction of lunar and planetary phenomena in the future. Sporadic and unpredictable events, such as meteor showers, comets and aurorae seem to have aroused little interest. The monthly lunar programme was particularly detailed. It involved watching for the Moon at its first and last visibility each month, and measuring the interval between sunset and moonset or moonrise to sunrise; measuring two time intervals (moonrise to sunset and moonset to sunrise) immediately before full Moon and the reciprocal



British Museum

corded in these diaries. The astronomers regularly noted aspects of the weather such as cloud, mist, rain and wind, especially when they interfered with astronomical observing, and seem to have taken special notice of rainbows and haloes. If compiled in sufficient quantity, these data might prove of use to modern climatologists. Other more mundane information relates to the quantities of a variety of commodities which could be bought each month for one shekel of silver, and measurements in the change in the level of the Euphrates at Babylon.

Ancient Chinese and other Far Eastern reports of new stars have been much in the news recently, especially their sightings of supernovae. The late Babylonian texts do not, however, contain any sighting of "new stars". This must be partly due to the short period of time actually covered by the surviving texts — only a few decades in total over 700 years from 750 bc to 50 bc when we add the scattered observation together. But the Babylonian astronomers' general lack of interest in



A cuneiform astronomical diary for the year 150 bc contains a vivid account of the total solar eclipse which occurred on 15 April that year (above). The Babylonians also recorded lunar eclipses, such as the one that began 12 minutes before sunrise on 3 November in the year 240 bc (above right). From such eclipse records, astronomers have calculated the rate at which the Earth's rotation is slowing down, due to the tidal effect of the Moon and the redistribution of matter inside the Earth.

non-repeating phenomena may also be to blame. A typical Far Eastern astronomical treatise devotes many pages to accounts of meteor showers and the fall of individual bright meteors: in Babylon, the records are silent. The Chinese were never restricted by a rigid observing programme.

Although they tell us nothing of past novae or supernovae, some Babylonian observations are of considerable importance to modern astronomy. These relate to lunar and solar eclipses. Helped by crude predictions, the Babylonians timed the beginning of the eclipse in relation to sunrise or sunset, whichever was nearer. They must have used some type of clepsydra (water clock), although we know virtually nothing about the design of such devices. Time intervals were estimated to be the nearest us (an interval of about four minutes), the time taken for the celestial sphere to turn through one degree. Because the tides are breaking the Earth's rotation, the length of the day is gradually increasing, at a rate of about two milliseconds per century. The day in Late Babylonian time was thus about 50 milliseconds shorter than present. Although the difference is small, so many days have passed since then (some 900 000 in total) that the accumulated clock error is large. As a result, a present day calculation of the time of day of an eclipse observed in Babylon would be several hours in error if we made no allowance for the variation in the Earth's rotation.

This shows itself in the following kind of example. Suppose we assume that the day which is determined by the speed at which Earth rotates on its axis has remained the same length since Babylonian times. We work backwards from the present to calculate at what time of day the eclipse happened on a particular date, corresponding to one of the observations recorded by the ancients. We find that an eclipse of the Moon should have occurred not long before midnight, and yet the Babylonians saw it begin

just after sunset. Such discrepancies allow us to calculate the rate of increase in the length of the day.

Comparison of modern calculations with the Babylonian eclipse records gives an excellent figure for the average rate of lengthening of the day over the past 2500 years. It works out at 1.78 milliseconds per century. The uncertainty in this figure is about 0.14 ms, and it arises not so much from inaccuracies in the Babylonian measurements but more from uncertainties in the modern estimates of the rate of expansion of the Moon's orbit. Because the visibility of an eclipse depends on the Moon's motion as well as the Earth's rotation, we must determine this quantity accurately. Reliable results should be available over the next few years from accurate range-finding which involves reflecting beams off mirrors left on the Moon by the Apollo astronauts and unmanned Russian probes. Only then will the full potential of the ancient data be realised!

Perhaps the most important conclusion of this investigation is evidence that the Earth is not slowing down as fast as would be expected. The argument goes as follows: if the change in the speed of the Earth's rotation was due only to the tides, then the day should lengthen by more than 1.78 milliseconds per century—the figure would be more like 2.5.

This slight discrepancy must be accounted for, geophysicists think, by changes in the way mass is distributed inside the Earth. The mass must be gradually becoming more concentrated nearer the centre. To keep the books straight as far as angular momentum is concerned, the Earth must speed up to compensate, and this partially offsets the tidal slowing. So as a result of their painstaking observations, the ancient Babylonian astronomers have unknowingly made an important contribution to modern knowledge about the Earth itself. □

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M O N I T O R

Sex hormone links handedness and the immune system

THE RESULTS of a survey published this month suggest that left-handers are, on average, around 12 times more likely to suffer from learning disorders, such as dyslexia, than right-handers. This association has been found in several studies, but the most recent one, conducted by Norman Geschwind at the Beth Israel Hospital in Boston and Peter Behan in Glasgow claims that left-handedness is also linked to a higher incidence of diseases associated with the gut and immune system. The link, Geschwind and Behan suggest, is the male hormone, testosterone (*Proceedings of the National Academy of Sciences*, vol 79, p 5097).

At first sight the human brain appears to be symmetrical, and for simple sensations and movements it is. For example, without exception the left-hand side of the brain controls the movement of and is first to receive sensory information from the right-hand side of the body (and vice-versa). However, when looked at more closely this symmetry exists only at a superficial level. An obvious behavioural indication of a functional asymmetry is the existence of handedness in humans, implying that for most people one side of the brain (usually the left) specialises in fine motor control.

It is now known that this lateralisation of function extends to many cognitive abilities. In around 90 per cent of the population the left hemisphere specialises in the comprehension and production of speech, while the right dominates over the left in its ability to recognise faces and objects seen from odd angles and to resolve other spatial problems. Furthermore, there is a good deal of evidence associating unusual patterns of hemispheric dominance with the incidence of learning problems and left-handedness. For example, a recent study made by Michael Galahurda and his colleagues in Geschwind's department has described a number of developmental abnormalities on the left-hand side of the brain of a dyslexic (*Archives of Neurology*, vol 39, p 333).

Both left-handedness and learning disorders are more common in boys than girls. So Geschwind argues that sex hormones must play a crucial role in the development of hemispheric specialisation. He goes on to point out that left-right differences in cognitive specialisation are much greater in males than in females. For example, although boys are usually slower than girls in their linguistic development, in adults a far larger area of the left hemisphere appears to be devoted to language in men than in women. Some years ago Sandra Witelson used a simple behavioural test to assess the relative participation of the two hemispheres in tasks involving spatial and tactual perception. She found that in boys, right hemispheric specialisation could be demonstrated as early as 6

years, whereas in girls left-right differences did not appear until about the age of 13.

Geschwind suggests that in males the normal growth of the left side of the brain is delayed by the presence of testosterone. Possibly the female sex hormone, oestrogen, controls the development of cognitive specialisation in females since oestrogen-sensitive nerve cells have been found in both hemispheres in new-born rats, but not in adult brains. Thus, Geschwind argues, hormonal abnormalities could have subtle effects on patterns of hemispheric specialisation and cognitive development.



Indeed there is a good deal of indirect evidence which suggests that this part of the hypothesis is correct. A recent report in the *New England Journal of Medicine* (vol 306, p 1202), for example, described the impairment of spatial abili-

ties in men suffering from male hormone deficiency syndrome, idiopathic hypogonadotropic hypogonadism.

Hypogonadotropic hypogonadism may provide a link with one of the other curious findings of Geschwind and Behan's survey—the high incidence of autoimmune disorders among left-handers. Many of these individuals suffered from inflammatory diseases of the bowel and gut, such as coeliac disease and ulcerative colitis, which are generally thought to arise as a result of the immune system's failure to recognise, and then ignore, specific organs in the body. Geschwind argues that the development of immunocompetence (the ability of the immune system to distinguish between self and non-self) may also be controlled by sex hormones. However, the recent work of M. J. G. Farthing of Tufts University School of Medicine in Massachusetts and his colleagues at St Bartholomew's Hospital in London (*Gut*, vol 23, p 608) shows that coeliac disease and hypogonadotropic hypogonadism often occur in the same patients, and they suggest that the immune defect may cause the shortage of hormones rather than the other way round.

Be that as it may, the work of Geschwind and Behan could provide a clue to the development of asymmetries in the brain, and to the types of behaviour they control. □

Cadmium—no cause for complacency

A NEW ASSESSMENT of the health risks from cadmium in the environment brings worrying news for the residents of Shipham in Somerset. The village hit the headlines three years ago when a government survey revealed high concentrations of cadmium in the garden soils of houses built on old mineral workings. Subsequent government statements said that there should be no health risk, even for people eating vegetables grown in the contaminated soils. And so far doctors have not detected any increase in death rates among the villagers (*New Scientist*, vol 94, p 647).

But a review of cadmium in the environment by the Monitoring and Assessment Research Centre (MARC), based at Chelsea College, University of London, casts doubt on those reassurances. It suggests that civil servants who argued unsuccessfully that garden soils in the village should be replaced may have been right. The MARC report, *Cadmium in the European Community*, concludes that a likely threshold of cadmium absorption in the body above which kidney failure would occur after 50 years continuous exposure is around 10 micrograms per day.

Diet tests conducted in Shipham in 1980 suggest that some residents of that village may be among the small fraction whose kidneys are at risk. According to the 1980 report of the government's

Shipharm Survey Committee, residents took as much as 120 micrograms per day in their diets. That, assuming a 10 per cent absorption rate, means a daily bodily dose of 12 micrograms. Smokers might absorb up to 15 µg per day.

The report predicts a further growth in the general level of cadmium in the environment throughout Europe. Total discharges are currently around 3400 tonnes per year. Less than 1 per cent of this is from natural sources—mainly volcanoes. Ninety per cent is discharged to land mainly through waste tipping of products containing cadmium. Industrial discharges to rivers are the principal source of water contamination. Iron and steel works emit most cadmium to the air.

But more important for human consumption are the 350 tonnes spread on Europe's farmland in phosphate fertilisers and the 130 tonnes deposited in sewage sludge. New rules under consideration by the EEC for limiting cadmium content of sludges spread on farms would make most British sludge spreading operations illegal.

But, says the report, most of the worst cadmium "hotspots" are close to old lead and zinc mines—both of which bring up cadmium with the other metals. Spoil heaps, like those on which new housing has been built at Shipham in the past 20 years, are probably most dangerous of all. □

Early animal husbandry at Lake Turkana

AN UNANSWERED question of African prehistory is the date when cattle, sheep and goats were first introduced from northern Africa, where they were first imported, into southern and eastern parts of the continent. Archaeologists now agree that hunter-gatherers and fishers in sub-Saharan Africa were keeping domestic stock earlier than was once believed possible. Now new archaeological data from Late Stone Age lakeside settlements east of Lake Turkana in northern Kenya point firmly to a date of around 4500 years ago for the first appearance there of domestic stock (*Nature*, vol 298, p 523).

The eastern shores of Lake Turkana have provided camp sites for hunting and gathering peoples for two million years, perhaps longer. The earliest human fossils and stone tools have attracted most of the recent research effort and public attention, but a multinational team led by R. B. Owen of Queen Mary College, London, is one of several groups looking at the more recent lakeside inhabitants and their aquatic and land environment. As part of their study of the ecology and water levels of Lake Turkana between 10 000 and 3000 years ago Owen, with his colleagues J. W. Barthelme, R. W. Renaut and A. Vincens, also investigated several Late Stone Age sites near the former hominid collecting area of Koobi Fora.

These scientists confirm that around 8500 years ago the level of the lake was up to 80 metres higher than it is today. The local inhabitants fished with barbed bone harpoons. They also made tiny

stone tools (microliths) and pottery, and they threw away fish bones and remains of crocodiles, hippo and several land mammals. In other words, they were typical Late Stone Age hunter-gatherers and fishers.

Between 8000 and 4000 years ago the level of the lake fluctuated a good deal but it probably did not drop to its modern low level. By 4000 years ago it was high once more. By then the lakeside dwellers had started to herd livestock. There are bones of domestic animals at the settlements but few remains of wild animals. However, the people still fished, though how they caught fish is unknown

because Owen and his team did not find any bone harpoons at their encampments. After 3000 years ago the lake gradually contracted and became the alkaline body of water it is today. There are still fishermen on its shores.

Archaeologists will regard 4500 years ago as early for the domestication of animals in the East African Rift Valley, but it is not unexpected because preliminary data from other sites in the Lake Turkana area had pointed that way. The date is based on several good radiocarbon determinations of bone and charcoal found at the encampments, which give it a strong measure of reliability.

By contrast archaeologists are treating with scepticism the much earlier date of around 14 000 years claimed by American archaeologist Charles Nelson for evidence of pastoralism further south at sites near Nairobi. This date remains suspect, despite its general airing last year in Richard Leakey's book and television programme *The Making of Man*. The identification of the mammal bones in question is uncertain, and the radiocarbon determination was based on only one bone sample.

Archaeologists can only guess at how domestic stock came to the Turkana area. The animals could have been brought by people migrating from the Sahara and Sahel which, by 5000 years ago, had started to dry up and become unsuitable for cattle. Or the animals could have been introduced to the indigenous people around Lake Turkana by cattle pastoralists who had moved into Ethiopia from the desert areas of the Upper Nile. □



Credit: M. W. J. P. H. van der Meulen/Amn/Chaito & W. J. P. H. van der Meulen

The el-Molo still fish Lake Turkana today

A vote of confidence for quantum mechanics

THE LATEST results that test the validity of quantum mechanics, the theory of sub-atomic behaviour, come down firmly in its favour and against the so-called "realistic local theories", which seek to overcome certain philosophical difficulties with quantum mechanics. Alain Aspect, Philippe Grangier and Gérard Roger, from the Université Paris-Sud, have performed an experiment that more closely follows the famous Einstein-Podolsky-Rosen-Bohm "thought experiment" than have previous attempts (*Physical Review Letters*, vol 49, p 91).

In 1935 Albert Einstein, together with Boris Podolsky and Nathan Rosen, proposed a "thought experiment" in which measurements are made on two halves of an atomic system as it flies apart. According to quantum mechanics the act of measuring the momentum, say, of one part influences the result obtained for the other part, suggesting a sort of "action at a distance", which some physicists find unsatisfying in a physical theory. The class of realistic local theories includes all those that attempt to overcome this difficulty.

However, theorist John Bell has shown that such theories always lead to

certain inequalities, expressions that put upper and lower limits on the amount of correlation between the two results of the thought experiment. Quantum mechanics, on the other hand, makes predictions that do not satisfy Bell's inequalities. Thus the inequalities provide a means of testing quantum mechanics against realistic local theories, at least in principle.

In 1952, David Bohm, a physicist at Birkbeck College, London, suggested a variation on the original thought experiment that fortunately makes it practicable: he proposed measuring the spins of two particles emitted by an atomic system. Specifically, what was to be measured was the orientation of the axis of each particle's intrinsic spin. The experiment is still difficult to put into practice, but several attempts have been made. The results generally do not satisfy Bell's inequalities, thus supporting quantum mechanics rather than the realistic local theories.

These earlier experiments remain open to certain criticisms, however, which Aspect and his colleagues believe they have now overcome. Their basic technique is to measure the polarisation

(effectively the spin) of two photons emitted during a transition in an atom of calcium-40 previously excited by laser radiation. In their most recent work the researchers have introduced "two-channel polarisers", which transmit photons polarised parallel to the polariser and reflect at 90° those perpendicular to it. This means that the apparatus detects photons polarised both parallel and perpendicular to the direction defined by the angle of the polariser, just as is required in Bell's inequalities; previously the researchers were able to measure only one sense of polarisation at a time.

By measuring the number of times the two photons emitted by the calcium-40 are polarised in the same and opposite senses, and repeating the measurement for four different orientations of the polarisers, Aspect and his colleagues determine all the quantities required in Bell's inequalities.

The results turn out to violate the inequalities to a greater extent than any previous data, and agree very well with the predictions of quantum mechanics. Thus, the researchers conclude "we are led to the rejection of realistic local theories". □

M O N I T O R

The brush warbler and the island sanctuary

SOMETIMES the desire to save a rare species conflicts with the equally laudable ambition to conserve the habitat in which it lives, and all the other wildlife that shares that habitat. This dilemma faces the tiny 27-hectare Cousin Island, 1500 km from the western edge of the tropical Indian Ocean, and home of the Seychelles brush warbler *Acrocephalus sechellensis*. The warbler just happens to prefer a form of vegetation—scrubland—that is by nature temporary, and in an ideal world would shortly give way to forest. But should one interrupt the natural regeneration of Cousin just to accommodate the warbler's special needs?

When John Crook of Bristol University visited the Seychelles 25 years ago he could find only 30 brush warblers. With Bill Thorpe of Cambridge he mobilised the International Council for Bird Preservation, the World Wildlife Fund and the then Society for the Promotion of Nature Reserves (now Royal Society for Nature Conservation) in a concerted drive that culminated in January 1968 in the outright purchase of the island for ICBP as a nature reserve. It remains the only internationally-owned nature reserve in the world. For the brush warbler, the move was a great success: now there are 300 individuals, and the problem is no longer one of last-ditch species preservation but of population management.

Just why the Seychelles brush



The brush warbler (below) likes to live among regenerating woodland on Cousin's flat land has been cleared and replaced with a plantation of coconuts, probably in the first decade of this century. When ICBP took over in 1968 the island was still run as a coconut plantation. Coconut trees are vulnerable to competition from the roots of other trees, so to maintain reasonable yields plantations had been kept clear of other vegetation by regular cutting. This policy left very little suitable habitat for the warblers, which were more or less confined to the swampy parts of the island. ICBP therefore deliberately encouraged the native woodland to regenerate by halting the cutting of vegetation and discouraging germination of coconuts.

A. W. Diamond

warbler should be so restricted in distribution is not clear, for in morphology, taxonomy and habits it is only a slightly aberrant member of the widespread genus *Acrocephalus*, to which the familiar reed and sedge warblers of Britain also belong. Historically the species was known from Marianne Island, from Cousin and from Cousine, only a couple of kilometres away, where they are occasionally still seen. On Cousin it occupies all the terrestrial habitats and is a typical foliage-gleaning warbler.

The story of the warbler's dramatic recovery is intimately linked with that

of changes in the vegetation. Most of the original forest of *Pisonia* and *Morinda* trees on Cousin's flat land has been cleared and replaced with a plantation of coconuts, probably in the first decade of this century. When ICBP took over in 1968 the island was still run as a coconut plantation. Coconut trees are vulnerable to competition from the roots of other trees, so to maintain reasonable yields plantations had been kept clear of other vegetation by regular cutting. This policy left very little suitable habitat for the warblers, which were more or less confined to the swampy parts of the island. ICBP therefore deliberately encouraged the native woodland to regenerate by halting the cutting of vegetation and discouraging germination of coconuts.

Brush warblers feed on insects and they forage mainly in the native trees and shrubs, particularly *Pisonia* and *Morinda*, both of which have regenerated rapidly since ICBP took over. But it has long been clear that warblers maintain higher densities in the regenerating woodland than in mature forest. In addition, in the last year or so it has been found that they have also invaded the coastal scrub to such an extent that they are more densely packed there than anywhere else on the island. Thus, as scrub is succeeded by regenerating woodland, and woodland by mature forest, the warbler population could again decline.

A decision will have to be taken soon between the needs of the birds and the re-creation of natural vegetation. To maintain as many warblers as possible it might be necessary to interrupt the natural succession of plants by clearing patches of forest and setting the clock back to the scrub stage. This would require a great deal of labour and supervision, and might also reduce the massive populations of tree-nesting terns. It would certainly conflict with an important original objective—to restore the natural vegetation of the island. Cousin's tiny size leaves little room for error in the decision that must be faced.

No taste of honey for flesh-eating bees

A SCIENTIST working in Latin America has discovered a species of "vulture bees" that collect dead flesh rather than pollen. The bees, a stingless species of social bees called *Trigona hypogaea*, harvest flesh from dead animals apparently by coating it with an enzyme that breaks it down, then chewing and partly digesting it. Once back at the nest they regurgitate the substance to their fellow worker bees, who metabolise it. Finally it is secreted into the brood cells to serve as food for larvae.

The scientist, David Roubik of the Smithsonian Tropical Research Institute in Panama, found *T. hypogaea* in the course of a study of stingless bees. "I got curious when I opened the nest and didn't see any pollen in it." The storage pots in the nests contained something that was neither pollen or honey, but which chemical analysis proved to be 20 per cent protein, a higher protein content than the "royal jelly" that is the end product of pollen-collecting bees. Roubik began to put two and two together while watching the bees at work. "At Thanksgiving we put out the remains of the turkey and soon there were hundreds of bees on it. They reduce things to skeletons in a matter of hours."

The sight of bees hovering around dead animals such as insects, snakes,

monkeys, anteaters and fish, is not unusual, but scientists had assumed that they were merely collecting liquid secretions from carcasses, perhaps to use as glue in building their nests. "No one had any idea that bees could supplement their protein diet with dead animals," says Roubik.

In fact *T. hypogaea* is an obligate necrophage—it relies entirely on dead animals for its food and is unable to collect pollen. Uniquely among bees, it has no pollen baskets and so would be unable to carry pollen. It is, however, equipped with big teeth on its mandibles, useful for getting flesh off carcasses.

T. hypogaea lives in lowland rainforest from the Amazon basin to Panama. Not having to rely on pollen could be a useful adaptation in a region where heavy rainfall cuts down on pollen-collecting opportunities. The bees seem to prefer amphibians, of which there are plenty in the wet forests in which they live, over other animals as prey.

The discovery of carnivorous social bees also raises an interesting question about evolutionary relationships. Wasps are known to eat animals for protein. Bees are thought to have evolved from wasps, and social bees to be more "advanced" than solitary species. So where to place a species of highly specialised, necrophagous bees?

M O N I T O R

Single cells flex their molecular muscles

IF A MOUSE wants to run, or a fish to swim, or an insect to fly, its nerves have only to issue the command and almost instantaneously the contractile filaments of its muscle engage and the animal moves. How different—apparently—from the simple amoeba, which, depending on its species, can take several seconds or even minutes to extend a single pseudopod, its first “step” in the business of moving its shapeless mass from one place to another. Yet there is every reason to believe that amoebae move by the same molecular means employed by the muscles of higher forms of life.

The great difference is that the contractile machinery of muscle is a fixed array of proteins ready for action as soon as the clutch (as it were) is engaged, whereas the machinery of amoeboid motion congeals and dissolves according to subtle shifts in the condition inside the cell. This elusiveness characterises all the most fundamental movements cells engage in (cell division being the most fundamental of them all), and the challenge of finding out how such movements come about is attracting an increasing number of biologists. Among them are Frederick Southwick and John Hartwig at Harvard University, in the laboratory of Tom Stossel, where molecule by molecule a picture of the amoeboid motor is beginning to emerge (*Nature*, vol 297, p 303).

The Harvard biologists have focused on the macrophage—not a free-living amoeba but a small trapped one that is derived from the blood cells and roves the circulation scavenging cellular debris, bacteria and other matter. Through indirect experiments on much larger amoebae, it has been possible to deduce that the principal components of the amoeboid motor are actin and myosin—the two proteins that make up the contractile filaments of muscle. And paradoxically, it is only through the remarkably detailed understanding biologists already have of the highly specialised and sophisticated machinery of muscle contraction that they have been able to begin to grasp the much more primitive mechanism of amoeboid motion.

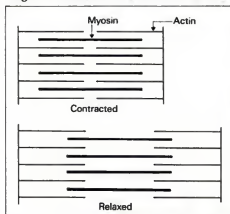
When a muscle contracts, the nerve signal to the muscle cell causes an increase in the level of calcium inside the cell, and that in turn causes the removal of a molecular “wedge” that keeps the actin filaments from contacting the myosin. As soon as the wedge is removed, the two filaments make contact, and that immediately sets off an enzymatic action that releases energy and induces changes in the myosin structure such that the myosin and actin filaments are caused to slide rapidly past each other and the muscle contracts (see figure).

The same sliding-filament action is believed to underlie the extension of pseudopods by amoebae—only the filaments form a loose network instead of a rigid array, and movement is brought about

by a simultaneous loosening of the network and contraction of actin-myosin complexes, which squeeze the fluid matrix of the cell into a pseudopod.

All these complex simultaneous changes take place in what is known as the cell's cortical layer—a gel-like layer of cytoplasm just inside the cell's outer membrane. When a pseudopod forms, a part of the cortical layer seems to liquefy and the cytoplasm streams into the pseudopod. Southwick and Hartwig have attempted to reconstruct, on the basis of experiments with purified amoeboid proteins, the molecular interactions that bring about these transitions.

The “liquefaction” of the cytoplasm, technically known as a gel-sol transition, is brought about by changes in the length of the actin filaments. Actin fila-



The machinery used by a macrophage (right) to move is a less organised version of that in a muscle cell (above)

ments are made up of a long string of globular subunits (monomers), and only in very specialised cells such as muscle do they form stable polymers of fixed length. For all ordinary cellular

purposes (and actin has many functions in cells), actin filaments are subject to constant assembly and disassembly from a pool of globular molecules in the cytoplasm. This means that the cell must have a means of regulating the exchange of subunits between the monomer pool and the actin filaments.

Globular actin molecules will spontaneously form filaments in a suitable salt solution, and when they do they produce a viscous gel. To turn this gel-like network into a fluid, the long actin filaments must be broken up into much shorter fibres—and it is to the understanding of this crucial fragmentation step that the Harvard laboratory has made its most important contribution.

The key discovery was a protein called gelsolin, which has two important properties (*Journal of Biological Chemistry*, vol 256, p 9693). First, it has a very high affinity for the ends of actin filaments, so high that it will actually displace actin monomers from the filament and bind to the end so created. Its second important property is that it can do this only at what for a cell is a rather high level of calcium. This is extremely important because many cellular signals are transmitted by transient changes in the level of calcium—including, of course, the signal for muscle contraction. So a gel-to-sol transition in the cortical layer could be brought about by a local change in calcium levels that would activate gelsolin to break the actin filaments and loosen the network, and at the same time probably also trigger the contractile interactions of the actin with small myosin filaments in the cortical layer.

But there is a problem. The two ends of an actin filament are not identical, and gelsolin binds only to one end—known, for rather complicated reasons, as the “barbed” end. Thus each time a gelsolin molecule breaks an actin filament and binds its barbed end, it leaves the other end (the “pointed” end) free to add more globular actin and increase in length again. Southwick and Hartwig have now supplied the solution to this problem. They have discovered, in extracts of macrophages, a protein that caps the pointed end of the filaments,

preventing them from growing. They have called this protein acumentin.

So by fixing the concentrations of actin monomers, gelsolin and acumentin, a cell could control with some precision the length of the actin filaments in its cortical gel, changing it relatively rapidly by adjusting the calcium level. At an increase in calcium,

the gelsolin cuts up the filaments and the fragments are promptly capped by acumentin. Once the calcium levels have dropped again, the gelsolin is released and the actin filaments rapidly regrow.

It is not only amoeboid cells that need to control the assembly of their actin filaments. Many animal cells, for example, go through a phase of migration during embryonic development, and many have specialised shapes that depend on the organisation of actin filaments into specialised arrays. The evolutionary peak of such specialised organisation is the muscle cell, whose proteins have provided the first clues about the fundamental motile properties of all cells. □



T E C H N O L O G Y

X-rays trace a path to higher density chips

BIG SCIENCE is helping American efforts to win the race for production of million-bit memory chips. During the next two years researchers at IBM's Thomas J. Watson Research Centre at Yorktown Heights, New York, will be studying ways of cutting the dimensions of components on chips with the help of X-rays. The radiation will be supplied from a synchrotron source just completed at the Brookhaven National Laboratory on Long Island, New York.

The IBM team will direct X-ray beams through masks onto silicon chips. The chips will be coated with materials called resists which are sensitive to X-rays. Where the chip is covered by the mask, the material is less resistant to solvents and can be etched away to expose a layer of silicon dioxide. Treatment with a strong acid then removes the exposed parts of the silicon dioxide layer. The exposed silicon can then be doped with impurities such as boron or arsenic to change its properties as a semiconductor.

This technique is already the basis of manufacturing integrated circuits, although ultraviolet light or an electron beam is the usual source of radiation. The advantage of using X-rays is the radiation's short wavelength (about two orders of magnitude less than that of ultraviolet light). This allows production workers to "write" finer features in the resist. Warren Grobman of IBM hopes that with X-rays his team will be able to make components in which the conducting channel is less than 1 micrometre wide—about half the minimum size of features marked by ultraviolet light. Grobman reckons that circuits that contain features 1.6 mm wide will still work when their dimensions are halved. In other words, it will not be necessary to redesign them to pack more components in. Such a drop in scale will result in chips that are four times as dense in components, so a memory chip, now made with at most 260 000 bits, could incorporate over a million bits. Grobman believes that X-rays could allow a further halving of linear dimensions beyond this; in that case, the circuits might well have to be redesigned.

Researchers have already tried making integrated circuits with conventional X-ray sources. The trouble is that such sources are weak: it takes from 30 minutes to irradiate one chip. With a beam from the 800 MeV synchrotron radiation source at Brookhaven, the IBM researchers hope to decrease this time by a factor of between 100 and 1000. An area of 36 square centimetres of polymethylmethacrylate (PMMA) resist, for example, will take about 20 seconds to

etch at Brookhaven. (PMMA actually takes longer to irradiate effectively, compared with most commercial resists; its exposure time represents an upper limit for what might finally be achieved.)

Sources of X-rays from hot, ionised

synchrotron; another is achieving uniform exposure to radiation over the whole chip.

Now the team will begin to experiment with making chips. First scientists will try simple masks with features such as lines and squares. Then they will use standard masks, made by a technique called electron beam lithography.

Grobman estimates that his team will be making standard chips within 6 to 18 months. But marketing computers that include such chips could be a decade away.

If X-ray manufacture turns out to be feasible, will companies build their own storage rings? Now such rings are only built for scientific research, and so are designed to be as flexible as possible. This makes them expensive. Britain's new synchrotron radiation source at Daresbury, for example, cost £5 million in capital costs alone. Grobman reckons that a source designed specially for lithography could

be much cheaper. For example, the Aladdin ring just completed at Stoughton, Wisconsin, could be a good design for an industrial machine. It cost no more than two electron beam lithography machines for making masks—about the same for a complete fabrication line for silicon chips. Growing interest in X-ray techniques for making chips in Japan, West Germany and Britain could expedite American plans. □



X-rays can cut the scale of memory chips

gases (plasmas) could etch chips at a rate somewhere between conventional X-ray sources and synchrotron radiation sources. This technique is under investigation, but is not yet proven as a means of production.

The IBM workers have had to overcome various problems setting up chips for attack by X-rays. One is how to isolate the chips from the ultra-high vacuum that must be maintained in the

Short cut to longer playing discs

TELDEC, the West German electronics company jointly founded by AEG Telefunken and Decca of Britain, has developed a new technique for making gramophone records. The process, which the company calls direct metal mastering, provides a short cut past two stages in the conventional process for making discs.

Record companies press discs from hot vinyl plastics squeezed between metal stampers which carry a negative impression of the grooves. The stampers are normally made by a tortuous process. A groove is first cut in a soft nitrocellulose lacquer master disc, and a coating of graphite dust or a silver solution makes the master electrically conductive. It is electroplated to produce a negative master copy in nickel (with ridges instead of grooves); a second stage produces a positive nickel mother which is an accurate replica of the lacquer master; a third stage produces a negative nickel stamper.

Teldec's process eliminates the first two stages by cutting the master groove directly into a copper coating on a blank steel disc. The stampers can

then be made directly from this disc.

A disc cutter needs hundreds of watts to drive the stylus even through soft lacquer. To cut through the much tougher copper, Teldec superimposes an ultrasonic signal on the audio signal to be recorded. This acts in much the same way as the bias signal in a tape recorder, which shakes up the magnetic particles at inaudibly high frequencies to make it easier for them to follow the audio frequencies. The direct mastering process mechanically excites a diamond cutting stylus, thus making it easier for it to follow the audio frequency signals being cut in the groove.

Because the copper coating is less prone to deformation than conventional lacquer, the grooves can be closer together. This enables Teldec to offer up to 15 per cent more playing time per record side. Teldec originally developed the technique for the now obsolete TeD videodisc format. The company launched the format on the continent in the early 1970s but withdrew it because of lack of support. It hopes to recoup some of its losses by selling the new technology to the audio record industry. □

T E C H N O L O G Y

China's long march leads to space development

CHINA IS STEPPING UP its efforts to win self-sufficiency in space technology. The government has formed a new department, the Ministry of Space Industry, to coordinate efforts in space. And it has postponed, for the time being, a plan to buy satellites from the industrialised world in favour of developing the hardware itself.

"Our government pays great attention to the space programme and is prepared to mobilise nationwide to achieve its goals," says Sun Jiadong who is vice-president of the Chinese Academy of Space Technology. He says the new ministry acts as the coordinator for work in other government departments, universities and research institutes.

One of the main thrusts of the space programme is in rocketry. The Chinese have been developing rockets since the

1950s, and 12 years ago put their first satellite into orbit with a home-made launcher. The satellite was a 170-kg scientific craft on board the Long March-1 launcher.

Since then China has launched a fur-

Peter Marsh, Vienna

ther 11 satellites, most of them with a more powerful rocket called "Storm". This can put two-tonne satellites into orbit a few hundred kilometres above the earth.

Now the Chinese are working on a still more powerful rocket, called the Long March-3. (Jiadong explains that Long March-2 was never used.) Within two years, this should carry a 900-kg experimental communications satellite that will operate in geostationary orbit.

"If you want to engage in space sci-

ence and technology, then a prerequisite," says Jiadong, "is to be able to launch your own satellites." The Chinese have big plans, many of them for educational broadcasting.

At present only one third of China's population of 1000 million can receive TV through conventional ground networks. Jiadong says that more TV transmissions are desperately needed to raise the standard of education. Every year, some 10 million people leave senior schools thirsty for more knowledge. The universities, by themselves, cannot meet the demand.

So China's government plans a TV satellite that will distribute programmes to the whole country from a geostationary orbit. China had talked to companies in western nations, particularly in West Germany about supplies of space hardware. Now the government is more keen to itself develop the equipment and ground stations.

Jiadong expects to see the scheme operating within the next 10 years. He says it will take a long time because of the sheer quantity of hardware required. "If we concentrated only on giving ground stations to our biggest schools, universities and factories, then we would still need 10 000 of them."

China also thinks that remote sensing of its land area by satellites can help it to lose the tag of "developing nation". The country is planning a ground station that will receive data from the American Landsat earth-mapping craft. Engineers are also talking to the French company Spot Image about buying information from France's Spot satellite when it enters orbit in 1984. Ultimately China would like to launch its own remote sensing satellites to search for rich deposits of oil and mineral. □

Maths lessons are out of this world

INDIA is mounting an ambitious space project to bring education to thousands of adults and children who cannot read or write. This week, India's public broadcasting company started beaming satellite TV programmes to about 200 receivers in remote villages dotted around the country.

By the end of this year, the number of receivers, which cost the Indian government some £600 each, should rise to 6000. The programmes will be broadcast four hours a day. In the mornings there will be two hours of programmes for children on basic mathematics, science and history. Adults will have their turn in the afternoon when main topics will include family planning and hygiene.

By satellite to Indian classrooms

Venkatappa Ramiah of the Indian Space Research Organisation in Ahmedabad, hopes that private individuals will buy more receivers and sets so that within five years the satellite programmes serve 90 per cent of India's population of 700 million. At that point, he hopes, the TV programmes will be screened virtually round the clock.

The service depends on India's multi-purpose communications satellite, Insat, launched by an American rocket earlier this year. An earth station near Delhi transmits radio wave containing information about the programmes to the satellite hovering in geostationary orbit, 36 000 km above the equator. Another ground station near Bangalore controls the position of the satellite which is also

designed to handle telecommunications traffic.

Besides educational programmes, the satellite will eventually distribute ordinary TV material. At present, the programmes are broadcast via terrestrial networks that receive and transmit microwaves. These cover only India's large towns. This means that less than 20 per cent of the population can tune in to TV.

The new satellite service is based on a successful experiment dating from 1975-76, by which people in 2400 villages received TV—courtesy of a satellite operated by NASA. During the trial some 250 000 people saw the programmes on sets in schools and public buildings. These will again be the venues for the new programmes' audiences, until private householders can buy sets and aerials. □

Satellites fight a plague of locusts

A £2½ MILLION programme to warn people in Africa and Asia about impending devastation of crops by locusts should begin next year. Earth stations in Nairobi, Kenya, and Niamey, Niger, will receive data from satellites about conditions in an area stretching from West Africa to India. With computers, scientists at the Earth stations will interpret the data to find out where locusts are breeding. In the last step in the chain, the information will be fed by telex and radio links to teams in aircraft that will spray the affected areas with pesticide.

The scheme is the brainchild of Jelle Hielkema who works for the United Nations Food and Agricultural Organisation in Rome. For several years he has investigated ways of interpreting satellite images to give information about locusts.

Hielkema has found that several of the Earth resources satellites now in orbit can provide useful details about the areas where locusts like to breed. These are predominantly river valleys where

the soil is silted or sandy and where rain has recently fallen. According to Hielkema, satellites can spot these conditions from their orbits high above the Earth. They can also give information about winds, indicating the direction in which swarms of locusts are likely to fly. The satellites involved in the project are the Landsat and NOAA Craft operated by the US, and Meteosat 2, which the European space agency owns.

The data from the satellites will supplement information gathered by workers trying to fight the locusts on the ground. But often, says Hielkema, this consists of little more than reports collected by people riding the affected areas on camels.

The satellite project should enable locust fighting teams, operating in about 50 countries, to react more speedily to the problem and wipe out the pests before they have a chance to multiply. When it is fully operating the satellite service will cost the organisers some £150 000 to run. □



T E C H N O L O G Y

More metal from old cookers

ENGINEERS at the Warren Spring laboratory at Stevenage have found a way to reclaim much more metal from throw-away cars, cookers, fridges and washing machines.

"Fragmentisers" in Britain produce about 1 million tonnes of scrap a year of which about three-quarters is iron and steel, relatively easy to pick out from the rest by magnet for remelting. About 25 000 tonnes of the rest of the broken-up scrap is composed of non-ferrous metals which a magnet cannot remove and which are usually sorted out from the waste by hand.

These metals include aluminium (the most important) zinc, brasses, other copper alloys, stainless steels with their high contents of chromium and nickel, and lead. Other metals are present in smaller quantities. Handpicking only gets about 40 per cent of these non-ferrous metals out of the fragmentiser scrap; the rest is thrown away. That represents a considerable waste, for even unsorted the 25 000 tonnes of non-ferrous metals produced from fragmentisers in Britain each year is worth £150 a tonne. Once sorted it is worth £350 per tonne. That means scrap merchants are throwing away over £5 million worth of valuable metals every year.

It is impossible for hand-pickers to sort out the smaller bits of metal from all the other much more voluminous rubbish; shredded plastic, seating material, wood and so on in the scrap. So the smaller bits just get missed. But now a team of engineers led by Maurice Webb in the materials reclamation department at the Warren Spring laboratory have developed a completely automated system to do the job.

After the scrap has been fragmentised and magnets have picked out the iron and steel from the remaining scrap, it goes through a vibrating screen which shakes out the fine dirt. Then the scrap is passed over a blast of air which blows away light bulky plastic sheet and foam. What is left is a much more concentrated mixture, about 50 per cent metal.

The scrap merchant can stop there, and hand over to the hand-pickers. They will get a lot more than 40 per cent of the metals out of this mixture, with much of the sorting work already done for them. Or they can go on to use the next device that Warren Spring has devised, simply a rapidly rotating metal disc, just over a metre in diameter. As the scrap falls onto it the rubber bounces off well over the side and so does the bulkier, heavier plastic. But the metals do not bounce. They edge out to

the side of the disc and fall off straight down into a separate compartment.

This leaves a mix that is mostly metal, with some stones and very heavy

minerals, for example. The device that takes mixed metals, stones and plastics, and puts it one bit at a time at regular intervals on a conveyor, scanned by X-ray fluorescence is being kept under wraps by Warren Spring for the time being. Once the laboratory has patents, it will doubtless find other applications, in sorting ore for treatment to extract



Science sorts the needle-sized bits from stacks like this

plastics. The next step is to separate the different metals, using X-ray fluorescence. A conveyor belt feeds the lumps of scrap one by one past an X-ray beam which makes each lump fluoresce at a wavelength characteristic of the material it is made of. A microprocessor

decodes the information to switch on a mechanical arm, a blast of air, or any other device to divert the lump of scrap off in the appropriate direction.

Other parts of the system; the spinning disc separator for example, may go on sale, on their own. One way or another, this new technology will save its users many times more than the £200 000 that it cost Warren Spring. □

When the polymer hits the fan

TORRENTIAL RAINSTORMS flood British sewers every so often; the sewers cannot cope with the extra surge of water and streets are flooded—or worse. We could build new sewers at £100 000 a throw, but they would lie empty most of the year.

Robert Sellin, of the University of Bristol's Department of Civil Engineering, has been exploring an ingenious alternative: adding certain polymers to sewage. The polymers reduce drag and increase the velocity of flow in the sewers. More water can pass through the sewers in a given time because there is less turbulence.

The water-soluble polymers are huge single chain molecules with a molecular weight of about 5 million, such as polyethylene oxide (Polyox WSR-301) or polyacrylamide (Magnaflow 156). These giant molecules speed the flow of water by stretching, and absorbing energy like a coiled spring does. Fibres added to flowing water can have a similar effect, but polymers have the advantage of being easily broken down by microorganisms at the sewage works. Anyway, these harmless polymers are often added to processed foods and drinks.

The first polymer dosing station in Europe has been running at Knowle in Bristol for the past five years—the result of a fruitful collaboration between Dr Sellin, the Bristol City Engineers, and Wessex Water Authority. The polymer, stored as a dry powder, is automatically added to sewage when water levels start to rise—which happens about 20 times a year. Dosing may go on for four or five hours if rain is very heavy. The addition of the polymer, at 18 parts per million,

increases the sewer's capacity by 25-35 per cent.

Dr Sellin is looking at other ways of getting the polymers into the sewage. The dry powder can cake up and clog the delivery hoppers, but the polymer cannot be stored in aqueous solution either; huge storage vessels would be needed, and even a 1 per cent solution is very viscous and difficult to pump. Storing the polymer as an oily emulsion is more feasible; a liquid containing 40 per cent polymer (by weight) is about the consistency of milk. When required the emulsion could be "inverted" and the polymer dissolved in water.

Dealing with overloaded sewers through "polymer drag reduction" turns out to be much cheaper than investing in new sewers. The dosing station at Knowle spends only about £500 on polymers every year, and about £10 000 to set up. Several more dosing plants are underway in the South West and other water authorities are starting to take an interest.

The ability of polymers to increase the velocity of flowing liquids has a host of practical applications. Polymers can be added to slurries of sand or pulverised coal to make pumping easier. A natural polymer, the polysaccharide xanthan gum, is already used in secondary oil recovery. Polymers might even find a place in medicine; they could reduce the beating that red blood cells receive while being pumped through heart-lung machines during open-heart surgery. Even the New York Fire Brigade benefits from polymers: a gel-emulsion reduces the spray from hoses and makes the water jets go further and faster. □



Why Britain does not need a PWR

Opponents to the plans to build Britain's first pressurised-water reactor at Sizewell in Suffolk say that we don't need the power station to meet electricity demand, that electricity consumers could end up paying for massive losses, and that there are questions about the reactor's safety

Czech Conroy

Britain's experience with nuclear power stations has not been a happy one. The House of Commons Select Committee on Energy in its report on the nuclear power programme last year said: "Enormous past nuclear investments have had exceptionally low productivity; great resources have been used with little direct gain and a serious net loss." The second phase of Britain's nuclear programme, involving the advanced gas-cooled reactors (AGRs), has experienced huge over-runs in construction time and capital cost, averaging six years and 100 per cent respectively. Professor David Henderson, who has worked as an economist at the Treasury, has called the AGR programme "one of the three worst civil investment decisions in the history of mankind". Nor are the recently ordered Heysham II and Torness AGRs likely to prove worthwhile investments. A recent report from the Electricity Consumers' Council *Nuclear Power and the Economic Interest of Consumers*, concluded that Heysham II "... involves the wasteful commitment of consumers' money earlier than necessary".

In view of the disastrous experience of the Central Electricity Generating Board (CEGB) with AGRs it is not surprising that the board has opted for a pressurised-water reactor (PWR) at Sizewell, in Suffolk. Nevertheless, the experience of the US with PWRs has been similar to UK's experience with AGRs — a series of over-runs in capital cost and construction time, and disappointing performances in operation. Studies have shown that nuclear electricity in the US is more expensive than that from coal-fired stations, directly contradicting the CEGB's claim that "nuclear stations generally produce electricity today at a cost below that of coal" (*New Scientist*, 17 June, p 766).

Charles Komanoff examines the economics of nuclear power in the US in his recent book, *Power Plant Cost Escalation: Nuclear and Coal Capital Costs, Regulations and Economics*. He found that in the 1970s the costs of nuclear stations increased more than twice as fast as the costs of coal plant; that the time needed to con-

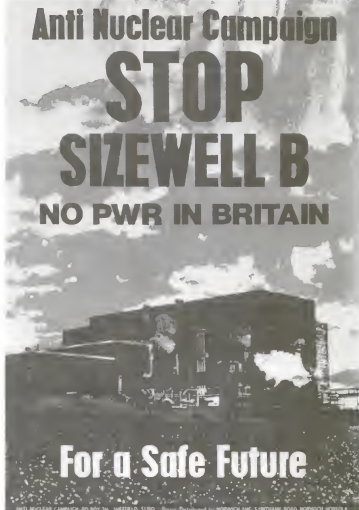
struct nuclear stations lengthened more quickly than that for coal stations; and that nuclear construction now costs over 50 per cent more than coal. Even the data published by the Atomic Industrial Forum, the US nuclear industry's trade association, show that electricity from nuclear plants installed after 1974 costs between 20 and 40 per cent more than that generated by new coal-fired plants.

A year ago the British government published a report from the Monopolies and Mergers Commission (MMC) which strongly criticised the CEGB's economic appraisal of proposed nuclear stations. The MMC concluded: "A large programme of investment in nuclear power stations, which would greatly increase the capital employed for a given level of output, is proposed on the basis of investment appraisals which are seriously defective and liable to mislead. We conclude that the board's course of conduct in this regard operates against the public interest."

One of the MMC's major criticisms was that the CEGB tended to use figures in its economic appraisal which "... were and are under-estimates and central estimates". The recent report from the Electricity Consumers' Council (ECC) on the economics of nuclear power shows that when relatively central estimates — of things like cost and construction time — are substituted there is no economic case for ordering AGRs ahead of need. Nevertheless, the CEGB still claims that ordering the Sizewell B PWR before it is needed to meet any increase in electricity consumption is justified even when central, and not target, estimates are used because its electricity will cost less than that from fossil-fuelled power stations, especially oil-fired ones. Let us examine some of these "central" estimates.

Construction time is crucial to the costs of nuclear power. The longer it takes to build a power station, the greater the interest charge will be, and with it the capital cost; the capital costs account for most of the cost of a nuclear station over its lifetime.

Sizewell B would be the first PWR to be built in the UK. The CEGB's central estimate for Sizewell B's construction time is 90 months. In the US it takes an average of 102 months to build a large Westinghouse PWR like that planned for Sizewell; and the average con-



Czech Conroy is energy adviser to Friends of the Earth, one of the opposition groups that will be taking part in next year's public inquiry into the Sizewell PWR.

struction time for Britain's AGRs is about 150 months. The UK has a history of poor labour relations which for many years has resulted in longer construction times for power stations and other large projects compared with other countries, including the US. So why does the CEBG believe it will build Sizewell B faster than the US is able to?

The CEBG's optimism is based largely on the assumption that, unlike other power stations, Sizewell B will not undergo changes of design during construction. This smacks of wishful thinking rather than objective economic appraisal. With dozens of PWRs operating throughout the world, there could well be more accidents or incidents leading to regulatory changes during the construction of Sizewell B. These would have implications for its design. The MMC report argues that in such an event "worldwide concern . . . would . . . have an effect on the PWR design used in the United Kingdom whatever the Nuclear Installations Inspectorate's policy". That the CEBG has not suddenly been blessed with infallible foresight is already clear as will be explained later in the discussion of the Sizewell B design.

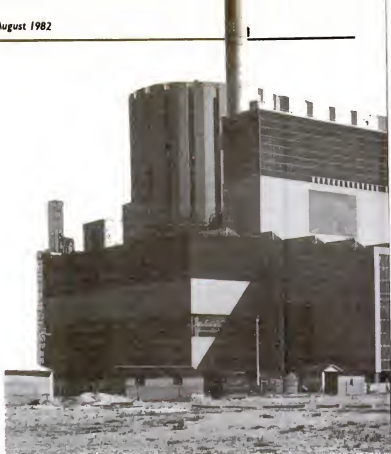
Room for improvements

A longer construction time than the CEBG assumes would mean higher capital costs. But before construction even starts other factors may increase capital costs. Design changes prior to construction are likely for two reasons. First, an earlier design for Sizewell B incorporated many important safety features which have been omitted from the design that the CEBG has now approved. The CEBG rejected this earlier design because it was too expensive. But at next year's public inquiry into the plans to build the Sizewell PWR there will be strong pressure for the CEBG to reinstate these safety features, particularly as some of them would reduce the exposure of power station workers to radiation. Secondly, as a result of the accident at the Three Mile Island (TMI) nuclear station in Pennsylvania, the US's Nuclear Regulatory Commission now requires various safety improvements, not all of which have been taken into account in the current Sizewell B design. At the public inquiry, however, there could well be pressure on the CEBG to adopt them. Again, these improvements are likely to push up the cost of Sizewell B.

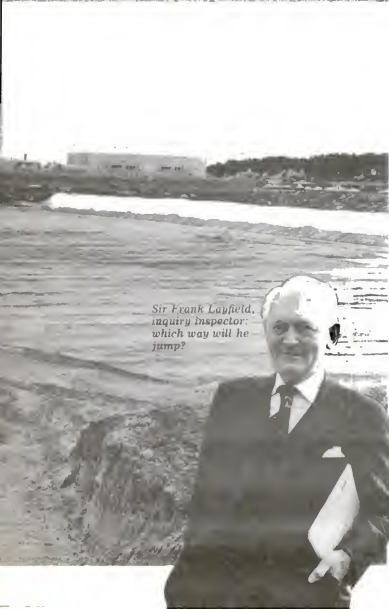
A second area where the Monopolies and Mergers Commission criticised the CEBG's assumptions about cost was the nuclear fuel-cycle. The MMC concluded that further real increases in costs are likely, and that "... a sceptical attitude towards nuclear fuel-cycle costs is appropriate in investment appraisal work". The CEBG has ignored the MMC's advice in its "statement of case" for Sizewell. The board assumes that fuel-cycle costs for nuclear power will decrease, but provides no evidence for this.

For the CEBG's figures on fuel-cycle costs to be borne out there would have to be a decrease in the costs of reprocessing and waste management between now and the year 2000. Yet in the 1970s the estimated cost of reprocessing oxide fuels (PWR or AGR) escalated dramatically. No one has yet reprocessed oxide fuel on a commercial scale anywhere in the world. It appears, therefore, that the CEBG is once again substituting wishful thinking for hard-headed economic appraisal.

Professor J. W. Jeffery of Birkbeck College, London, argues that reprocessing costs for oxide fuel are likely to be about *double* those assumed by the CEBG for Sizewell B (*Energy Policy*, June 1982, p 76). In the absence of any explanation from CEBG as to why reprocessing costs should decrease, Jeffery's figure is the more appropriate one to use in appraising the board's



Dungeness B (left) is Britain's latest home-grown AGR station. Massive delays and overspending have turned it into a financial disaster—the electricity industry says the imported PWR design it wants to build at Sizewell (in the hole shown below) will be different despite American experience



investment plans for the next few years.

Overall, it appears that if the CEBG used genuinely realistic estimates of the costs of nuclear power, there would be no economic justification for ordering Sizewell B. If Jeffery's assumptions about the costs of electricity from nuclear and coal-fired power stations prove to be correct, the CEBG's losses over that station's lifetime would be massive. In fact, the CEBG could lose well over £1000 million rather than make the £500 to £1100 million savings postulated by the board.

Building Sizewell B before Britain needs it is a "high-risk" strategy. On the CEBG's assumptions there would be a return of £17-£37 million a year averaged over the lifetime of the plant. But on other assumptions there would be a net loss. Furthermore, most of the savings would not occur until the next century. The cost of this is an investment of £1000 million which will raise electricity prices this century. The MMC's report on nuclear power concluded that electricity costs would continue to rise in real terms until the late 1990s, and that "... a substantial element of the increased costs up to that time relate to the capital charges of the investment programme itself".

France, with its large nuclear programme, is experiencing exactly this problem. The French equivalent of the CEEB, Electricité de France, has gone heavily into debt in trying to finance its nuclear programme. Two years ago it needed a Fr5000 million loan from the government. Now it faces its worst financial situation for 30 years and requires a further loan of up to Fr8000 million.

The CEBG's economic case for Sizewell B rests on the implicit belief that the station's *possible* long-term benefits make it worthwhile to incur the *definite* short-term costs. The prudent (and conventional) view would be that they are not.

Economic cost is a sufficient reason for rejecting Sizewell B. But there are also environmental and social costs associated with nuclear power: nuclear waste disposal, the hazards of uranium mining, the overlap with nuclear weapons technology, increased vulnerability, and so on. As these issues have been widely debated I consider only one specific issue here — the safety of pressurised water reactors.

The safety of PWRs has aroused considerable concern, and they are generally thought to be inherently less safe than gas-cooled reactors. There is a very high power density in the core of a PWR. If the flow of water coolant through the core were disrupted for only seconds, therefore, the core's temperature would rapidly increase, possibly causing the core to melt. In 1979 the Three Mile Island reactor came within an hour of a meltdown, following the shutdown of the emergency core cooling system. A second inherent weakness in the PWR's safety concerns the use of water as a coolant. The problem is that if the reactor's pressure dropped some water would turn into steam. As steam is a poor coolant this could seriously impair the cooling of the core, increasing the likelihood of a meltdown.

The US's Nuclear Regulatory Commission has identified numerous unresolved safety problems with PWRs. The hazards which they pose are not likely to be acceptable over the lifetime of PWRs currently in operation or under construction in the US. The Sizewell B design fails to take many of these safety concerns into account; for example, system interactions, environmental qualification of safety equipment and the ability to remove residual heat.

The Sizewell B design also fails to take account of certain design features required in the wake of the TMI accident. For example, the NRC is now applying stricter

criteria to new plants so as to improve the hydrogen control systems. Robert Pollard, who used to be a nuclear safety engineer with the NRC, has concluded that the Sizewell B design does not meet these stricter criteria and would be unlikely to receive approval from the NRC.

Furthermore, some of the design changes which the CEBG has made to improve safety have their disadvantages as well as their advantages. For example, the two additional safety injection pumps depend upon the reliability of the reactor's control system, and so may not, in the end, increase overall safety.

The National Nuclear Corporation, which will be involved in building Sizewell B, is aware of the safety problems posed by PWRs, as is clear from the initial design it submitted to the CEBG in April 1981. This design contained several substantial safety improvements. The CEBG rejected it, however, because some of the improvements were too expensive.

Common-mode failure

In the design put forward in April 1981, there were four well-separated emergency core-cooling systems — key safety systems in the event of an accident — whereas in the current design there are two pairs of emergency core-cooling systems.

As a result, the safety systems in the new design are more likely to suffer a "common-mode" failure; that is, two or more systems simultaneously failing to work for the same reason. In addition, the arrangement of the emergency core-cooling system in the original design appears to be much more effective.

Safety features to protect workers from exposure to radiation have also been dropped from the new design. For example, the April 1981 design had an "in-service inspection control room". The room would have shielded the crew from radiation during inspection and maintenance of the steam generators, the main source of radiation exposure in PWRs. These are important omissions, as workers' exposure to radiation in PWRs has been about five times higher than in gas-cooled reactors.

The Sizewell B design already differs in several respects from other PWRs, and further extensive changes are likely as I have already explained. There is not even any operating experience of the standard design upon which the Sizewell PWR is supposed to be based. Only two plants with this design are being built, and neither will come into operation until 1984 at the earliest.

The CEBG's commitment to Sizewell B can only be explained by its concern to find a competitive nuclear system to diversify its sources of electrical energy. But the nation as a whole has to be concerned about diversifying all energy sources — not just electricity, which supplies less than 10 per cent of Britain's delivered energy. The nation must also avoid becoming heavily dependent on centralised electricity production, because of its vulnerability to disruption.

Nuclear electricity is neither the only way, nor the best way, of replacing fossil fuels in the major uses of energy — heating buildings and fuelling road vehicles. Low-temperature heat, for example, which constitutes

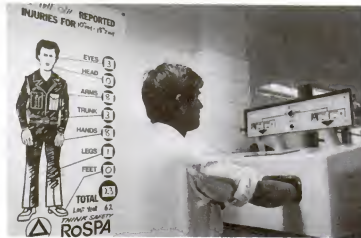
more than half Britain's energy needs, can be supplied by passive solar space-heating systems, solar water collectors and geothermal district heating schemes.

Between now and the turn of the century, the top priority for displacing fossil fuels in electricity generation should be reducing demand and electricity conservation. Many utilities in the US and elsewhere have already recognised the advantages of this approach in terms of speed, simplicity and low cost. They have initiated schemes, involving loans or grants, to encourage customers to implement conservation measures.

Three-quarters of the electricity consumption in the UK is by the domestic and industrial sectors in virtually equal proportions. Domestically, space and water heating are the major uses of electricity, and several studies (for example by the Watt committee) have shown a variety of cost-effective conservation measures — such as loft and wall insulation, draught-proofing and tank lagging — can reduce demand by about two-thirds. The remaining domestic usage of electricity is in electrical appliances (refrigerators, cookers, and so on) and also in lighting.

Jorgen Nørgård and his colleagues at the Technical University of Denmark have shown that the efficiency of household electrical appliances and lighting can be

increased by as much as 400 per cent using known and well-tried technology. The Philips SL* light bulbs are an example of a product already on the market which has achieved this quadrupling of efficiency. Japanese refrigerators provide another example of increased efficiency of appliances: some current models are already more than twice as efficient as the average 1975 model. Nørgård estimates that in most cases the consumer will recover the cost of improving the efficiency of domestic appliances in saved electricity in a couple of years — a far faster payback than for



When the light turns red, the worker is contaminated with radiation. Safety features to protect workers have been dropped from the latest PWR design

the capital invested in nuclear power stations.

In the industrial sector more than half of the consumption of electricity is in electric motors. Increasing the efficiency of and, more importantly, substituting hydraulic drives can reduce demand substantially.

Studies of energy-efficient futures — by Gerald Leach and colleagues at the International Institute for Environment and Development (*New Scientist*, vol 81, p 81), and by David Olivier and Hugh Miall at Earth Resources Research — have found, in Leach's words, that nuclear power "... could easily be abandoned if desired". The benefits of such energy-efficient futures have been well-summarised by Leach and his associates in their report, *A Low Energy Strategy for the United Kingdom*. They conclude: "An energy future of this kind is a future of low risk. It offers material prosperity and the benefits of national self-confidence, yet without the nagging, conflict-prone pressures of resource constraints and the need for the public to accept large expansions in energy supplies. It would relieve many environmental problems and release for other purposes investments that would otherwise have to go to energy supply."

Instead of investing in Sizewell B we should now grasp the opportunity to pursue this new, low-risk and prosperous energy future. □

A jungle kept for study



N. Smythe

Barro Colorado Island in Panama has been a biological reserve since 1923 and now enjoys permanent protection. The long-term, continuous investigations that such status allows are transforming our understanding of the ecology of tropical forests

**Ira Rubinoff and
Nicholas Smythe**

From 1 October, 1979, a new treaty between the United States and Panama changed the effective sovereignty over the Canal Zone, which the US had administered since 1903; the attention of the world was focused on the future of the Panama Canal. But international biologists were equally worried about the future of the Barro Colorado Island, 1600 hectares in the middle of Gatun Lake, the reservoir that supplies the water for the canal. Were their fears well founded?

Fortunately, the negotiators of the treaty took decisive and imaginative action to ensure the island's protection and accessibility. In a separate agreement annexed to the treaty, they declared Barro Colorado Island a "nature monument" under the terms of the Western Hemisphere Convention of 1940 on Nature Protection and Wildlife Preservation. The Smithsonian Institution of Washington DC was designated as its custodian.

Barro Colorado has been a biological reserve and scientific research station since 1923. It is a reliable, comfortable and accessible area of moist tropical forest which thousands of scientists have used as a field laboratory; in 1979 1180 biologists came from 32 countries. Recently demand has increased exponentially, and now researchers have to be turned away.

The island is one of the few truly protected natural areas of neotropical forest, which means that many animals may be seen here which, in other ecologically similar areas, have become too shy or too rare. It also has one of the best tropical biological libraries in the world, with more than 500 journals and 18 000 volumes, including the recently published *Flora of Barro Colorado*, an important advance. Barro Colorado also has a resident staff and fellows supported by institutes.

Dr Ira Rubinoff is director of the Smithsonian Tropical Research Institute in Panama and Dr Nicholas Smythe is head of the Smithsonian's Office of Conservation and Environmental Education.

Biologists have always been intrigued by the diversity of organisms in tropical forests, and have proposed various theories to account for it. One holds that the permanent superabundance of food, resulting from the benign environment, is the main factor. But studies at Barro Colorado in the late 1960s were among the first to contradict this view and show that an important ecological characteristic of this forest is a season of deprivation of unpredictable severity. Since then, a long-term study of seasonal and other temporal changes has been looking at the effects on all the living things of changes in climate, number of predators, and of food. We keep records of climatological phenomena such as the rainfall and sunlight. The phenology (that is, the repeated pattern of growth, especially as influenced by climate), of leaf, flower and fruit of several hundred individual trees has been recorded for nearly 10 years, as have fluctuations in the numbers of night-flying (phototropic) insects.

The data recorded by staff scientists, supplemented by those from the studies of visiting researchers, are forming a bank of baseline information that will help us to understand this complex system. The monitoring programme demonstrates one of the great advantages of this type of biological research station: of long-term studies that seldom yield spectacular results but, without which, we would remain ignorant of the basic functioning of an ecosystem. Such insights can never be gained through sporadic visits, nor through studying unprotected forests.

Since 1946 the Smithsonian Institution has been responsible for the scientific management and protection of the island through the Smithsonian Tropical Research Institute (STRI). This was authorised, and the budget appropriated, by the US Congress. The resulting stability has helped to make Barro Colorado one of the best known areas of tropical wilderness in the world; it is comparatively small but the fauna and flora are typical of more remote areas. The 366 species of birds, 170 of which nest on the island,

include several such as the crested guan (*Penelope purpurascens*) that are heavily hunted elsewhere. Unfortunately, the three species of macaws natural to the area all fell victims to the pet trade before the reserve was established. Mammals are also abundant, with tapirs (*Tapirus bairdii*) and red spider monkeys (*Ateles geoffroyi*), both on the IUCN Red Data Book of endangered species, moving about with apparent indifference to the human observer. Unfortunately the island is too small for resident jaguars (*Felis onca*) or pumas (*Felis concolor*). Both used to visit but, as the surrounding areas became progressively more disturbed, their visits became less frequent until it is now by no means certain that these big cats still occur. Among the 90-odd species of mammals recorded on the island are three other cats, five primates and 46 bats.

The fauna is still changing. Species that are adapted to second growth conditions that occur in more open spaces move away as the forest gets older. Some deep-forest

examining the role of natural gaps in the canopy, in the process of forest regeneration. A team of biologists, led by Stephen Hubbell from the University of Iowa, is mapping a 50-hectare area of forest in order to identify every tree in the area and to learn about the diversity of forest species and dispersal of propagules (that is, seeds, buds or other parts that break off to form new plants).

Some pioneering biological field studies were done at Barro Colorado. C. R. Carpenter's study of the behavioural ecology of howler monkeys in 1934 was one of the first with truly objective observations, and has long stood as a model for students. Theodore Schneirla spent 35 years studying the ecology and behaviour of army ants (*Eciton* spp.) at Barro Colorado; his description of the social behaviour of army ants published in 1935 is a field biology classic. Frank Chapman first visited the island in 1925: his primary interest was in ornithology and he wrote 32 books and articles about the birds, and other aspects of the forest.

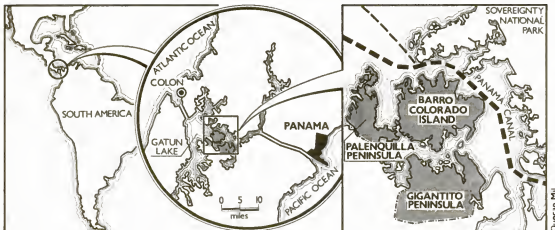
Technological advances have stimulated other studies on the island. Recently, Merlin Tuttle used light-enhancing, night vision devices and high-speed photography, triggered photoelectronically, to study the ability of bats to find and devour calling frogs in the nearly total darkness of the forest floor. Others have used tiny transmitters to study the movements of animals as small as bats, or radio tracking to study sloths and monkeys.

Because the island is too small to support resident populations of some organisms, and because mainland forests are being destroyed and there is a steadily increasing demand for research space on the island, the Smithsonian applied for land-use licences for some peninsulas adjacent to Barro Colorado. In 1978 they were given three peninsulas on the east bank: Bohio, Buena Vista and Frijoles. Much of the land of these areas was farmed until then: the forests are considerably younger, and the fauna was impoverished because of hunting. The forest will eventually regenerate, but meanwhile researchers can carry out projects that are not feasible on the island, for example on the white-tailed deer (*Odocoileus virginianus*). Such species are adapted to the secondary growth that occurs in clearings and around young trees, and so no longer thrive on Barro Colorado. Clearings of a controlled size and known age of the peninsulas of the east bank will encourage such species without detracting from the health of the biological community.

The 1979 Panama Canal treaty assured the continued use of these peninsulas and also designated a similar buffer zone for the west bank. The Panama Canal Authority now leases two areas known as Palenquilla and Gigantito (see Figure), to the Smithsonian. Although they are not, as yet, completely inventoried or surveyed, we know that they include some types of habitat such as swamp forest that are not available on Barro Colorado.

The additional 3800 ha of mainland area on both sides of the canal presented the STRI with new problems; primarily that of protection. Although destruction along the banks was prohibited, enforcement was practically nonexistent. In addition, small slash-and-burn areas had steadily spread, farmed by the people who were generally employed elsewhere and who would be in the area only when actually cutting, burning, planting or harvesting.

Hunters have been attracted to the area by the belief



Barro Colorado Island and Palenquilla and Gigantito, leased to the Smithsonian since 1979

species that normally live in dispersed populations have apparently been unable to sustain reproduction. There are no more white-lipped peccaries (*Tayassu pecari*): the island is probably too small to support even one of the large bands in which they live. On the other hand, capybara (*Hydrochaeris*), the world's largest rodent, have arrived within the past 10 years.

There is a similar variety of amphibians (32 species) and reptiles (28 species). Several species of anurans—frogs and toads—have been the subject of studies into systems of communication and partitioning of ecological niches. The largest reptile in the area is the endangered yellow crocodile (*Crocodilus acutus*) which is still fairly common around the island although it is hunted in other parts of Gatun Lake. Iguanas (*Iguana iguana*) have also been persecuted to the point of rarity or extinction throughout much of their range. They spend most of their adult lives in the treetops and are difficult to census, but they are abundant on Barro Colorado and probably occur there in approximately their natural density. They have a traditional, communal nesting site, which has been extensively studied.

Non-insect invertebrates include several species of freshwater crab, a lobster-sized shrimp, several species of scorpion, peripatus (*Oncophora*)—a strange, primitive creature half-way between a segmented worm and an arthropod—and various spiders including a large tarantula (*Sericopelema*). As for insects, there are at least 100 species of ant and 60 of termite. Henk Wolda of the STRI has found 1100 species of Homoptera (the cicada group), about a quarter of which are new to science.

The availability of a comprehensive flora has encouraged other investigations. A number of researchers have been



N. Smythe

Howler monkeys—objects of C. R. Carpenter's classic studies

that game animals must be plentiful if an area is protected. The lack of enforced hunting laws and the widespread use of dogs have completely extinguished the most popular species over a large part of otherwise suitable habitat. Those who hunt for sport are relatively easy to control because they are few and tend to be both conspicuous and more respectful of the law. Those who hunt for the pot or the market are more difficult to control. The length of broken coastline makes it easy for poachers to conceal their canoes, and because the trees deaden sound so effectively, gunshots can be heard only for a few hundred metres.

As soon as they had agreed on the west bank additions, the Smithsonian put up signs warning that entry is restricted. They cut 11 kilometres of trail along the Palenquilla and Gigantito boundaries, and put up a barbed wire fence along the entire length to keep out cattle from some of the adjacent farmed areas. The number of patrol wardens was increased from 7 to 15 and members of the Panamanian National Guard began to help out on a temporary basis. The wardens conduct foot and boat patrols

24 hours a day and seven days a week; they also conduct aerial patrols, particularly in the dry season.

Because the nature monument extends over a considerable part of the adjacent waters of Gatun Lake, the Smithsonian has bought large patrol boats. Vast areas of the lake are inaccessible to motor craft because of the tree trunks submerged when the Chagres River was dammed to form the lake in 1914, and so a zone of restricted entry, of about one to two hundred metres off shore, has been established. Anyone found within this zone in possession of firearms or dead game animals can be arrested and charged with poaching.

Once the boundaries and legal status of the nature monument were settled, the Smithsonian began to develop a management plan for the additional areas. Many researchers want a programme of clearing selected areas periodically so as to maintain samples of all stages of



Ocelot



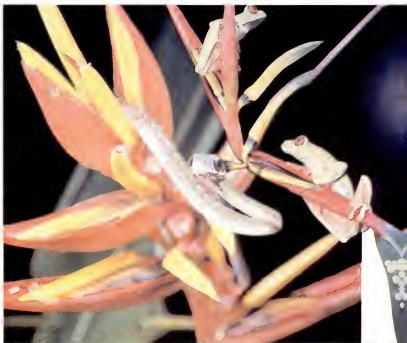
Merlin Tuttle photographed this fringe-lipped bat, *Trachops cirrhosus*, as it emerged from its roost in a large hollow tree in Panama (above). The bat is attracted by the mating calls of frogs and swoops down to make a successful catch (right). To escape attack, frogs often sing from the protection of thorn bushes or noisy waterfalls



Some more of the denizens of Barro Colorado (below). The vine snake is one of 28 species of reptile; the tree frog, one of 32 species of amphibian. The spiders are quite simply astonishing and there are few areas where the endangered red spider monkey, *Ateles geoffroyi*, moves with such indifference to man

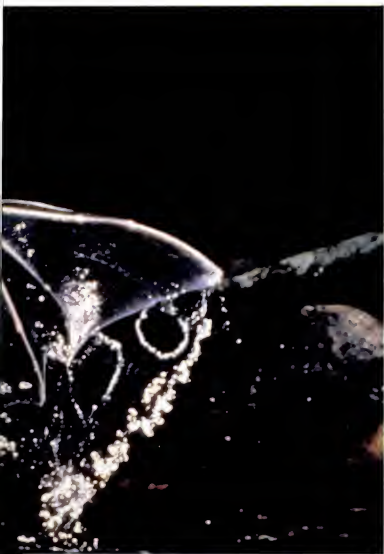


Two species of *Morpho* feed on *Gustavia*



Vine snake on *Heliconia*

Agalychnis tree frogs with eggs



A spider catches a bat

forest regeneration. One proposed project would attempt to short-cut the lengthy process of natural regeneration by planting a mixture of late second growth and climax species on what was recently a rice-growing area; that is, planting species that normally would encroach only after several generations of pioneer species and other quick-growing types had come and gone. Another proposal is to try to find a native tree that will successfully compete with *Panicum maxima*, a fire-resistant, soil-debilitating African grass that has become a plague in much of the neotropical region.

President Royo gave biological research in Panama an important boost when he decreed that the Republic's National Directorate of Renewable Resources (RENARE) should set aside 22 000 ha of forest in the former canal zone to be known as Sovereignty National Park. It includes the experimental Summit Gardens and the Pipeline Road Reservation, an area of some of the finest forest in central Panama, protected for many years because of a pipeline built during the Second World War. The new national park is contiguous with the nature monument and together they constitute over 40 per cent of the remaining forest in the watershed basin of the Panama Canal. We hope that the areas will allow for some of the larger rare species of birds and mammal, such as macaws, harpy eagles and jaguars, to be preserved. The prohibition of hunting, though still not entirely effective, has already resulted in a noticeable increase in some of the game species.

The nature monument and the national park are important components in the canal watershed. As such they govern, to some extent, the water supply for the canal and the country's two largest population centres. Because of their close proximity to the cities there will undoubtedly be pressure to use the Barro Colorado for recreation or agriculture.

Nevertheless Panama is now firmly committed to protect these unique resources and the decision to forgo small and short-term economic benefits will be offset by the area's future value as comparable regions of tropical moist forest disappear; several recent studies indicate that 50 per cent of existing tropical moist forests will have been destroyed by the year 2000.

With its new legal status and the continued encouragement of the US and Panamanian governments, Barro Colorado should serve as a model to catalyse the establishment and support of similar reserves elsewhere. □

Dr Merrin Tuttle, Milwaukee Public Museum



A youthful red spider monkey

Photos by N. Smith

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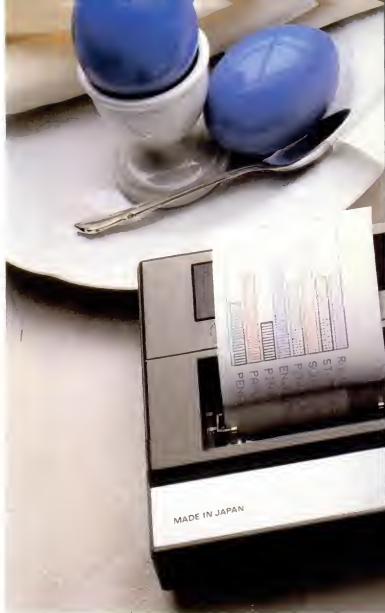
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Operations	+ , - , * , / , () , < , > , <= , >= , = , < , > , AND, OR, NOT, &
Others	INKEY\$, TIME, , : , "

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Statements	LPRINT, TAB, LF, ROTATE, COLOR, GLCURSOR, SORGN, LINE, RLIN, CSIZE, TEXT, GRAPH, LCURSOR

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Roman ships in a German hotel

The last of the Roman navy that lost out to the Barbarians from the north more than 1500 years ago has surfaced in a hotel garage in Mainz

James Hansen

It comes down to this—what was a fleet of 1500-year-old Roman warships doing buried in the garage of the new Mainz Hilton? Workmen clearing the site for construction of the new hotel found the first traces of the Roman craft. Archaeologists called in to evaluate the find went on a day-and-night dig for 2½ months to discover the well-preserved remains of at least 10 ships dating from the last days of the Roman Empire. It may be that this graveyard of ships is remarkable evidence of the final collapse of Roman defences against barbarian invaders in the North; a souvenir of the beginning of the end.

The craft found in the dig were warships. The most common type was a fast patrol boat of a kind the classic texts call *naves lusoria*. The two Roman legions that were stationed at Mainz, in present-day West Germany, used these craft to patrol the Rhine. The river, with the legions behind it, was the bastion against ill-intentioned barbarians; the principal line of defence against the Goths, Visigoths, Vandals, Franks and others who eventually overwhelmed the Empire of the Romans.

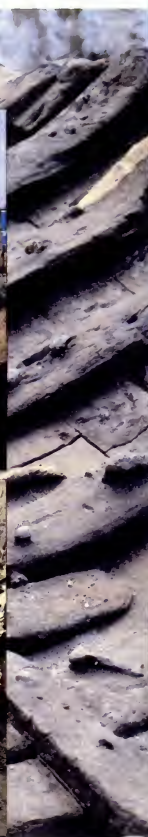
In the West, the northern border of the Empire followed the Rhine all the way to the North Sea, near what is today Rotterdam, and was thick with commercial shipping as well as military traffic. The Romans even used the river to transport timber and stone from as far away as the Alps to build fortifications in the Low Countries where these materials were scarce. But according to the leader of the dig, Gerd Rupprecht, an archaeologist from the West German Amt für Bodendenkmalpflege (Archaeological Conservation Authority) "what we've found are definitely military craft. These patrol boats are built for speed, long and very narrow, with room for 26 rowers—13 on a side—but no room for cargo.

"We believe they are the first oar-powered Roman craft to be found along the Rhine. Civilian shipping depended on the current and small sails to go downstream, and on pushing with poles or towing from the shore to go back up. Rowing crews were well-paid specialists and too expensive for civilian commercial use."

These fast patrol boats were not the only discovery. Ship number three turned out to be an unusual type of imperial transport. "The only other example of this kind of craft has been found in Egypt, though we know it from the old texts," comments Olaf Höckmann of the Central Museum of Roman Antiquities who is a specialist in nautical archaeology and a collaborator on the dig. "It is a beamier, wider boat, powered by both oar and sail. It had a cabin or a hut above deck. These craft were used to carry high-ranking officials of the imperial government on tours of inspection."

These ships all went down at roughly the same time not quite 16 centuries ago. Their good state of preservation is due to their burial by the shifting course of the river. The site of the dig is about 150 metres from the present bed of the Rhine. Centuries of flooding and sediment carried by the river built up an overburden of 7 metres of clay and sand above the sunken ships. That, and the fact that they lie slightly below the present-day water table, kept oxygen from getting to the hulls. The oak planking and timbers

Over 2½ months the building site yielded 10 Roman ships—war ships, designed to be rowed, and some more than 20 metres long. Burial in Rhine mud ensured their preservation



could not rot and the iron nails could not rust.

Dendrochronology (tree-ring dating) has been carried out on several of the craft. Ship number one, a patrol boat, turns out to have been built with oak cut in AD 376, according to Eckhardt Hollstein, of the University of Trier, who did the dating. He thinks the wood was used green, so that is probably also the date of the ship's construction.

That same hull, though, underwent major repairs later with wood cut in 385 and then again in 394, according to Hollstein. This is interesting because the last Roman



Pics. by Michael Dettel

troops were pulled back hurriedly from that part of the frontier only a few years later, in 406, to defend the heart of the Empire against the first invasion of the Goths. It is an event which Edward Gibbon, who had a flair for the dramatic and didn't like Germanic invaders, described in this way: "The barriers which had so long separated the savage and the civilised nations of the Earth were from that fatal moment levelled with the ground . . . the fortresses of the Rhine were abandoned, and the safety of Gaul was protected only by the faith of the Germans

and the ancient terror of the Roman name."

Both faith and terror proved insufficient. Only four years later, in 410, Alaric and his Visigoth companions sacked the city of Rome itself. The Empire never returned to Mainz, or to the Roman province of Germania Superior of which it had been the capital.

So the question is this: have Rupprecht and Höckmann found the remains of the Roman river fleet scuppered by the legionnaires when they were suddenly ordered to pull back from the Rhine?

There is much to suggest that they have. The craft, which appear to have been in reasonably good shape at the time of their sinking, were carefully stripped of all movable material before being abandoned. "We found no trace of oars, anchors, masts or any kind of cargo," says Rupprecht. "Even the rower's benches had been carried away. And," he adds, "there is no indication that they were sunk by direct enemy action."

Höckmann points out, "we don't think this site was simply a wrecking yard. There are repairs on some of the craft, particularly on ship number three, which do show signs of wear. You do not overhaul a ship in one moment and scrap it in the next."

Still, the hypothesis that this sunken fleet is a telling trace of the sudden collapse of the Empire is, well, dramatic. Rupprecht and Höckmann find the idea attractive; the dates are right, the ships and the apparent circumstances of their sinking are right; but the proof is not conclusive. Just to be fair about it, they would like to find another plausible explanation for the mass sinking of at least 10 ships. The count may go higher; there seem to be fragments of other craft as well. "There is the possibility," Rupprecht and Höckmann hedge carefully, "that, say, an exceptionally severe winter and resulting heavy ice on the Rhine sank the fleet . . . taking into account the kind of damage, we may in one or two cases consider its having been caused by ice pressure." On the other hand, if the crews had been around to haul the boats out of the water, that would not have happened.

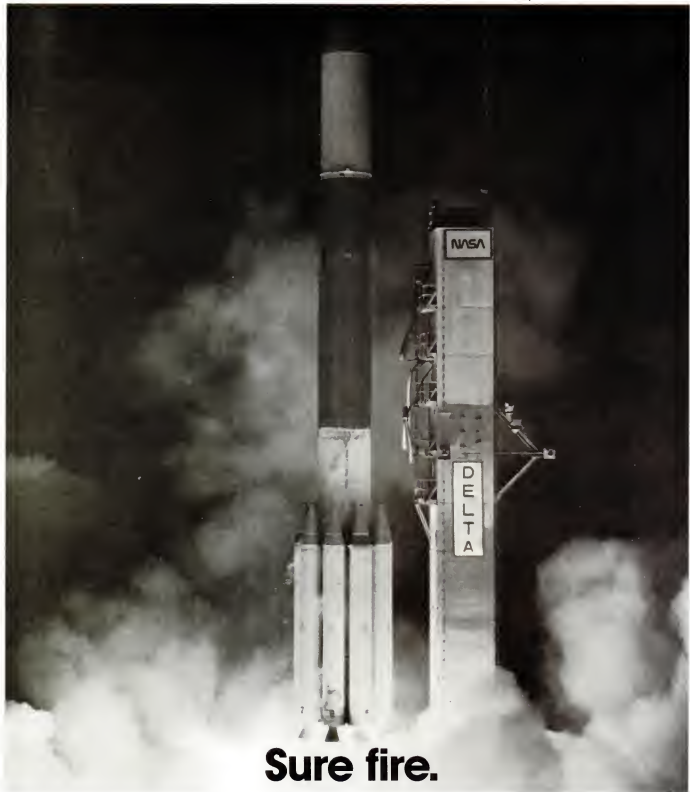
Waterlogged timber must not be allowed to dry too quickly. The ships are well worth preserving, but who has room for them?

However it was, these warships are very old and unquestionably saw times that now are almost mythical. "The late date," says Höckmann, "implies that the Mainz boats, or some of them, may be considered to give testimony to the heroic attempts of late 4th century emperors like Valentinian to secure the Rhine frontier."



All of this poses an interesting problem for an eventual curator. These naval relics are not small (several of the best-preserved reach lengths near 20 metres) nor are they of overwhelming aesthetic interest. They look like exactly what they are: extremely old boat hulls. For now, they are being stored in tanks of water in a Mainz suburb. Left to dry out in the air, the wood could shrink to half the dimensions it has in its present super-waterlogged state. The Germans hope eventually to be able to preserve the craft by treating them with polyethylene glycol.

When that is done, someone will have to decide what to do with them. Still, they are too much history to be locked up in a museum sub-basement. The Fall of the Roman Empire deserves better. □



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F O R U M

Could life have happened by accident?

H. N. V. Temperley has calculated that life could have started on Earth without intervention from outer space

THE OLD argument between the theory of special creation and the idea that life could have evolved from the inorganic materials that existed on the primitive Earth, has recently acquired a new dimension. Fred Hoyle and Chandra Wickramasinghe—in two recent books, *Evolution from Space and Diseases from Space*—emphatically reject the traditional view of the origin of life. Most scientists accept the conventional idea that on the primitive Earth, there was no ozone layer in the atmosphere, thus opening the way for the synthesis on the seashores of simple organic compounds, such as amino acids, under the influence of the ultraviolet light from the Sun.

Hoyle and Wickramasinghe claim that the idea that life could have evolved from such a "primitive soup", is "too improbable". They put the same question in another way. Where can the vast store of "information" in a single-cell organism have come from on such a theory? They claim to have shown that the odds against "life" evolving are $10^{100,000}$ to 1. They make various other claims, for example, that it is much easier to explain the fossil record if Darwin's ideas are supplemented by the idea that the Earth is continually collecting "loose" genes from space. Also they claim that some evidence on epidemics is more easily explained if the viruses that caused them originate from space.

I shall not discuss the two latter points, but I shall criticise the argument based on the related concepts of "probability" and "information". The conventional connection between "information" and "loss of entropy" is admittedly useful in some contexts, but not in all. For example, if a river freezes and then melts it has little meaning to say that it acquired a vast store of "information" when it frozen and lost it again when it melted, or to ask where the information "came from". The whole essence of the concepts of gain and loss of "information" and "entropy" is that they do not obey simple conservation laws but are altogether more subtle.

The form of the argument based on probability of spontaneous occurrence is easier to deal with. I envisaged the possibility of such calculations in my book

A Scientist Who Believes in God (Hodder and Stoughton, 1961) but, at that time, we simply did not have the data we needed to enable us to make the required calculations. I now claim that we can at least estimate the probability of what must have been the first step

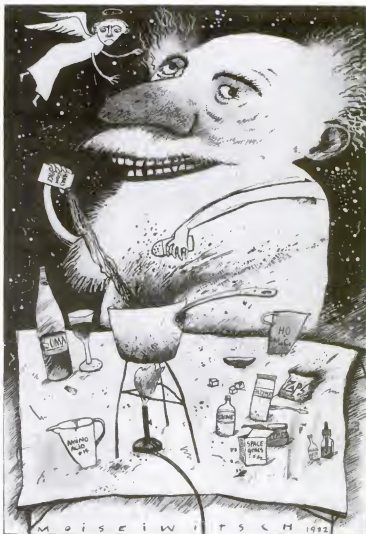
in by accident is estimated at 20^{-9} , say 10^{-9} . The probability that a thousand different enzymes appeared by accident in a small volume is thus $10^{100,000}$ to 1 against, as they claim.

Unfortunately for this argument, no one, as far as I know, seriously claims such an origin for life! As Mark Ridley has pointed out (*New Scientist*, vol 92, p 188): "Darwinians emphatically do not believe that the whole enzyme system of a cell was put together by the random combination of amino acids. The enzyme system of the cell is thought to have evolved from simpler systems." We now have much more knowledge than we had in 1961. We have discovered the genetic code and are beginning to understand how proteins are synthesised. We can now speculate usefully on what the "simpler systems" might have been like and can assign some rough probabilities to certain happenings.

I suggest that Ridley's "simpler system" consisted of a "proto ribosome" containing only one, perhaps two enzymes. One enzyme would act as a "jig" enabling successive amino acids to form chains. We may also need a second enzyme to act as a "cutter" when the chain reaches a certain length. To enable our suggested first step in the evolution of life from the primitive soup to take place—the formation of large numbers of assorted protein chains—it is sufficient for one "proto ribosome" of the kind I have just described, to have appeared at one place on the Earth, once during the 10^9 to 10^{10} years.

Once formed, in theory, such a complex can churn out vast numbers of protein chains. (At this very early stage the absence of genetic coding simply ensures that not one but a very wide variety of chains will be produced, some of which are themselves capable of acting as enzymes. If we arrive at a chain that is not quite capable of so acting it will, in due course, degrade and its material becomes available for fresh "attempts".)

Once the essential "joining" enzyme has formed, protein chains will be created very rapidly and the stage is thus set for further evolutionary steps. Professor Wickramasinghe has criticised



in the evolution of life.

Life is generally defined as a "self-replicating" process, and simple estimates show that the probability that something very similar could have happened spontaneously during the 10^9 or so years that the Earth has been cool enough amounts to near certainty.

Hoyle and Wickramasinghe arrive at the famous figure of $10^{100,000}$ to 1 as follows: A living cell has a chain of amino acids of which there are 20 different kinds. They suggest that, for an enzyme to work by the amino acid chain assuming its correct configuration in space, at least 20 to 30 key amino acids must be "right". The probability of this happen-

Carol Montewich

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this last statement as "delightfully unquantifiable". In our present state of knowledge it is indeed, but this is emphatically not the same as saying that "it did not happen thus". Perhaps the next step was the appearance of cell walls?

We can fairly easily estimate the various large number which, multiplied together, give us an estimate of the total number of configurations of amino acids that have been "worked through" since the Earth became cool enough! (The general theory of statistical mechanics states that a system, such as our "soup" of amino acids in a pool of the primitive sea, will, as time goes on, steadily work through a representative selection of all the possible configurations. The estimates are all "give or take a few powers of ten," but this is accurate enough for our purpose.) Coastline of "panga" say 10^5 miles, volume of suitable water at sea shore say 10^{15} cu.cm, say 10^{20} amino acid molecules per cu.cm, each molecule makes 10^3 collisions per second. Life of the solid Earth about 10^{17} seconds. Thus in all, some 10^{20} amino acid configurations will have been "tried out" since the world began!

If we accept the probability of 10^{-20} that a completely random chain could act as a "joining" enzyme, it is "almost certain" that there has been time to produce large numbers of protein chains so that a very large number of workable enzymes have appeared. Put in another way, the spare factor of 10^{20} implies that there has been time for the spontaneous appearance of something more elaborate in structure than just a joining enzyme, a "cutter" also. This would be very close to a "self-replicating" system, if we accept its property of simultaneously producing other types of system at the same time.

My conclusion, which, for religious reasons, I do not particularly like, is that what must surely have been the first step in the evolution of the primitive soup could have occurred by accident and that it is therefore unnecessary to invoke either divine creation or the appearance of proto-life from interstellar space to "explain" the initial step. Arguments based on "inverse probability" are always difficult, but science would be infinitely the poorer if we could not use them!

Professor H. N. V. Temperley recently retired from the Department of Applied Mathematics at the University College of Swansea, University of Wales.

Hot gossip

Has someone finally come up with a sensible and permanent answer to the problem of radioactive waste disposal?

... to show that things can be wrong.
Radioactive Waste: Available from the Association of County Councils at 66a Eaton Square, London SW1.

The crocodiles that count

Martin Hollands describes a crocodile-farming project in Papua New Guinea

OUR LATEST consignment of sea mail brought with it the issue of *New Scientist* containing Rupert Grey's article on the United Nations Crocodile Project (vol 92, p 328). This presents a reasonable outline of the objectives of the Crocodile Management Project in Papua New Guinea, but it is misleading on a number of points.

The project aims to replace the killing of wild crocodiles. It does this by "harvesting" live hatchlings and rearing them in farms. The government initiated the project in the late 1960s. By 1977, when assistance from FAO/UNDP started, there were already 7000 crocodiles on farms in Papua New Guinea (PNG). Although the United Nations gave considerable assistance to the project between 1977 and 1981, and still provides two volunteers and support, it is not accurate to call it the "United Nations Crocodile Project" or to say the UN was instrumental in its establishment.

Due to the extent and nature of the crocodile habitat in PNG the task of assessing the population size is daunting, and it will be some time before we can do with any confidence. We have, therefore, tried to avoid any premature estimates. However, I should com-

ment on Grey's claim that PNG has a "growing" population of 200 000 crocodiles. The only area where we can attempt to qualify the population is the Sepik flood plain in the north of the country. Extrapolation from measuring the densities of nests in a sample of areas indicates this area alone supports in the order of 80 000-100 000 freshwater crocodiles (*Crocodylus novaeguineae*) and 20 000-26 000 salt-water crocodiles (*C. porosus*). The Sepik floodplain is a relatively heavily hunted area with less than 50 per cent of the country's crocodile habitat. Thus the whole of PNG is likely to support a population of approximately half a million crocodiles, producing up to three quarters of a million eggs each year.

It is fairly common these days for people who visit PNG, especially on adventure-orientated expeditions, to over emphasise the lack of contact between the indigenous population and the "outside world". Rupert Grey does not seem to have resisted the temptation. It is true that without popular support it can be difficult to enforce conservation laws in remote areas, but a total moratorium on export of skins could have been enforced if considered beneficial.

Initially a law banning the trade in crocodile skins of more than 20-inch bellywidth was introduced to protect the breeding stock. Although neither species was thought to breed in the wild until about 10 years old, not the 3-4 years stated, it is now thought that a significant number of *C. novaeguineae* breed when still under 20 inches. Therefore, the government here is considering a reduction in the size limit. In any case, now that a network exists for villagers

to sell live hatchlings to commercial farms, small crocodiles do not have to be killed for financial gain. This led to popular support from both hunters and the industry for the wasteful trade in small skins to be stopped, and in May 1981 a ban on skins below seven inches was introduced.

Martin Hollands is Senior Ecologist with the Crocodile Management Project in Papua New Guinea.



They catch them young in PNG—then fatten them in crocodile farms

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A combination of many factors such as fluctuating food supplies, seasonal water supplies, lack of cultural tradition in animal husbandry, and logistic problems in supportive services, all led to the conclusion that village rearing does not provide the most efficient utilisation of the available crocodiles. Most crocodile rearing now occurs on a small number of technically sophisticated commercial farms, each capable of holding 10 to 20 thousand crocodiles, with a steady supply of cheap feed, such as poultry offal, ensuring high growth rates. Village people benefit by selling the hatchlings they catch to these farms through a network of holding pens and government-run collecting farms.

Rupert Grey states that "only one out of every five hatchlings taken will survive the first year of life". If this were true the whole concept of crocodile farming in PNG would be untenable. Fewer than 5 per cent of hatchlings die whilst passing through the government's live-purchase network, and once on the commercial farms mortality is low, under 10 per cent in the first year, and then virtually zero until the crocodiles reach culling size. I suspect that Grey meant this if these hatchlings had not been taken only one in five would have survived the first year in the wild.

It is obvious that a project based on the cropping of animals from the wild, particularly of species covered by the Convention of International Trade in Endangered Species, requires careful management, and that an integral part of this is the monitoring of the wild population to ascertain the effect on cropping levels. However, the survey technique described by Grey, that of using searchlights at night to count eye reflections has been repeatedly rejected by both the FAO and the government ecologists on the project. It is considered inappropriate to the conditions existing in PNG.

Results of night counts depend on many variables (including air/water temperatures, state of the Moon, weather, water levels, vegetation, level of hunting) apart from the number of crocodiles present. Before such surveys can be helpful it is quantifying the effects of these other variables; this may be worthwhile in relatively uniform habitats when a high proportion of the crocodile population lives in rivers: most in the vast areas of surrounding swamps where they would not be accessible to such a survey. The Crocodile Management Project does have an active programme monitoring the wild population. It is, however, based on repeated aerial surveys of the density of crocodile nests and detailed monitoring of the harvested crop.

We still have much to learn about the crocodile population in Papua New Guinea, but there is every reason to believe that we can have a multi-million dollar industry which benefits the country, the rural people—and the crocodile population. □

White-line flashers

Donald Gould has been driving his family round the bend

I'VE JUST GOT home from a weekend by the sea in beautiful Sussex, where I was born, and the best of the English used to breed. I went to visit a much-loved elder sister, and with me came my dear wife, and just one of my many dear children, and only one of my "two damned dogs". And so, in theory, the journey there and back, undertaken in a well-behaved, roomy, and comfortable vehicle of foreign manufacture, should have constituted a considerable part of the pleasure of the expedition.

After all, one child in the back of a car is a source of delightful and thought-provoking comments on the passing scene, often raising questions or expressing viewpoints which had never occurred to the fuddy-duddies strapped into the front ("Daddy, why don't they build factories underground so that you could keep cows on the top, and then they wouldn't get knocked down when we have a war either?"), whereas two or more children in the back inevitably create an ongoing and noisily explosive PLO/Israeli-type situation of a kind which makes any kind of motorised outing sheer hell.

And whereas attempting to take two leashed pooches into a pub garden for the necessary tea-break generally involves yappings of canine jealousy and excitement, and trippings over twisted leads, and general embarrassment all round, taking in just the one is like a Crufts "Champion of the Show" parade, which evokes "Oh, look! Isn't he a darling!" simperings from some of the more sentimental occupants of neighbouring tables who don't appreciate the truly evil nature of the beast. (Children are very like dogs, when you come to think of it. Both species suck up to adults when alone in their seniors' presence, and when they think they might thereby earn a favour, but neither kind of animal can desist from ugly strife when in the presence of their own kind, even though they know damned well that this will evoke displeasure among the bosses, and the consequent denial of rewards. Stupid animals, the two of them, I say, although I suppose Nature will out.)

Of course, driving in a foreign car (at least, one of fairly recent registration) largely relieves you of the nagging fear that the next moment will find you

in a lay-by, or on the hard shoulder of a murderous motorway, desperately awaiting costly succour because some ill-fitted item of equipment essential to the motion of the vehicle has broken down under the unplanned-for stress of having to function continuously for more than half an hour at a time.

So there we were—one husband, one wife, one child, one dog, travelling in a reliable Italian gomobile on a sunny Saturday morning toward the seaside home of a well-loved relative, and with

the prospect of coming back through some of the most softly lovely parts of our island toward a cherished cottage of our own on the evening of the following day—it should have been 36 hours of pure delight. Well, it wasn't.

The hours we spent at the edge of this precious stone set in a silver sea were indeed delightful, but the going and the coming back were horrid.

My sister lives just about 100 miles

from me. The journey took four hours. She lives about as far from London as we do, but she's on the chalk of the South Downs, hard by the Seven Sisters, and we're on the drying-out peat of the black, flat Fens. To get to there from here we have to go through the Great Wen.

Some of my more perceptive readers (both two of you, my dears) will have twigged from the last paragraph what this rambling *belle-lettre* is all about.

Our roads have been designed by idiots, and are used by idiots.

It took us about 45 minutes to get to London, on our way down to the south coast, because we have a motorway, called the M11, which is a triumph of engineering skill and planning. It precipitates people like me into the far East End of London, and then more or less leaves them to their own devices.

It is perhaps very good for a few barristers and management consultants, and Conservative MPs, and similar happy citizens, who live in the Essex lushlands, and who now find it easier than heretofore to swan in to the office, but it is ridiculous to empty the incoming trade from East Anglia into the maze shopping streets of Wansford and Leyton and Dagenham.

Having got to London from Cambridge in under an hour, we then spent nearly twice as long, threading our way to the



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south side of the Dartford Tunnel, some 15 miles further on, and, having finally crossed the Thames, we enjoyed another couple of hours of "pleasure" motoring (as they say on the insurance forms) sidling our way through side-streets to the coast.

Well, I do believe we could have made the journey in no less time a century-and-a-half ago, using a coach-and-pair. But what really riled me about the journey was the behaviour of my fellow-travellers.

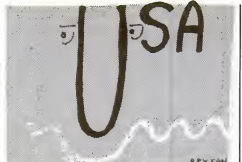
At some dreary point in the journey through East London, for example, I was sat on the outside lane of a two-lane dual carriageway road, proceeding at a few miles per hour above the permitted limit of 40, or whatever, and there were

cars in front of me, and cars to the side of me, so that we formed a solid block of moving steel plate. But I am a pusillanimous motorist, and like to keep a proper distance from the chap in front, so there was a little bit of vacant road ahead of me—20 yards, maybe.

Then some fool, cruising 18 inches behind my back bumper, started flashing his headlights, indicating that I should shove aside to let him take the space ahead, despite the fact that happy motorists were head to tail to my left, so that I couldn't have got out of the flasher's way, even had I wanted to.

After another mile or so a space did appear on my left, and my pursuer nipped into it, and overtook, and nipped in back ahead of me, thus gaining at least a second's worth of precious journey time. This manoeuvre at least enabled me to catch a glimpse of the flasher, whom I expected to be a pushy double-glazing salesman, or whatever, driving a Cortina. She turned out to be a blond charmer, with two pleasant-looking infants strapped to the back seat, and a gentle grandma by her side.

I don't know. Perhaps we should subject applicants for driving licences and architects of motorways to an intelligence test, rejecting all those who scored between a low/normal level. That way we could probably rid the country of 90 per cent of its motorists, and 60 per cent of its roads, and the rest of us could get about in comfort. □



when it was the only thing in reach when I had to sneeze. As soon as I grabbed some off the roll and sneezed into it, I found that I had to sneeze again. Then again and again. The fragrance of the toilet paper was triggering my hypersensitive nose. (I've since been told that the scent is applied only to the roller, from where it diffuses into the paper, but that does nothing to soothe my nose.)

Then there are the dolls that a neighbour gave to my two daughters. One doll is named "Blueberry", and the other "Raspberry", and that's sort of what they smell like. The girls loved them, and the older girl took hers to bed. Alas, she is asthmatic and shares my allergies, and the smell soon had her up coughing. A good scrubbing got rid of a little of the scent, but we still had to banish the dolls from the bedroom.

The latest assault on my nose came in the mail—a sample bar of soap. Fragrance is added to all mass-marketed soaps, even the most innocuous brands, says Vee Savre of International Flavors and Fragrances. However, the smell of the sample bar was so overpowering—even through the unopened wrapper—that we tossed it directly into the trash.

Allergies obviously can have a big impact on the sense of smell. Dr Henkin estimates that up to 25 million Americans have their sense of smell impaired by allergies. That includes me; I can't smell much of anything when my nose is in its usual clogged state. However, he says that "by and large fragrances aren't a major problem". Savre goes further, saying that allergy problems caused by fragrances are "very, very rare". I, for one, am not convinced.

Perhaps I'm just prejudiced against strong scents, but cluttering our already polluted air with unnecessarily strong fragrances bothers me. As Henkin points out, little research has been done on our sense of smell. Though it can bring us such pleasures as the aroma of a good meal, it can also be easily damaged, as indicated by Henkin's estimate of 16 million Americans who have lost their sense of smell.

Could overstimulation of our sense of smell ultimately damage it, much as too much loud noise (or loud music, which is only another form of noise to our hearing organs) can damage hearing? Nobody even seems to have asked that question. Do I smell a pollution problem? □

ENIGMA

No 174

The bumbling burghers of Hamm

by Bert Brooke

ALL SKIING enthusiasts will be delighted to learn that the locally constructed funicular on the approach slopes to the Grosser Fischengnomme will be completed for the forthcoming winter sports at Hamm-Garnisch.

A reliable informant says the completed line will comprise of four discrete sections; each section is to traverse a different but quite constant gradient. All gradients subtend angles less than 45° from the horizontal, and each section raises the line exactly 450 metres.

Using a large-scale map, the Hamm burghers read off the various section lengths and translated these readings directly into numbers of track lengths—thus the small additional components of length due to the various gradients were blissfully ignored in the initial order for track. A further order for 32 track lengths corrected the burghers' delinquency and has enabled completion of the project.

The track is supplied only in pre-fabricated 10-metre lengths. Fortunately, the revised calculations show that an integral number of track lengths will still be needed for each of the corrected section lengths.

Please notify the total length of the completed line (in kilometres).

A £5 book token will be awarded to the sender of the first correct solution opened on Thursday, 2 September. Please send entries to Enigma No 174, New Scientist, Commonwealth House, 1-19 New Oxford Street, London WC1A 1NG. The Editor's decision is final. The winner of Enigma No 171, Addition digits all wrong was Tony Williams of Muscat, Sultanate of Oman.

Answer to Enigma 171

Addition:
digits all wrong

2 7 6

2 1 3 7

4 9 0 4

Scent pollution

Jeff Hecht turns his nose up at an environmental problem

THE MEDICAL profession has largely ignored our sense of smell, laments Dr Robert Henkin who runs the centre for molecular nutrition and sensory disorders at the Georgetown University Medical Center in Washington. He says that some 16 million people in the United States have lost their sense of smell, yet his taste and smell clinic is the only one in the country.

But if physicians are ignoring the sense of smell, marketers certainly aren't. Fragrances are pervasive in consumer products; they're added not only to such products as soaps and air "fresheners", but also to toilet paper, dolls and what are euphemistically called "feminine hygiene products". Fragrances are a big business, according to International Flavors and Fragrances of New York, which makes many of them. You might say it's nothing to sneeze at, but I take issue with that wording. In fact, my concern is sneezing at it.

My problem is allergies. According to some tests I took a few years back, I'm allergic to essentially everything with fur or pollen. A pleasant smell to someone else may be an allergen to me.

Take toilet paper, for example. I discovered scented toilet paper accidentally

QUESTIONS OF ETHICS

Michael Kenward has been pondering on ethics over a free lunch or two

COMPUTER EXPERTS rarely debate ethics with heart surgeons. But that happened recently when computer people, energy experts and medical researchers came together to entertain a group of journalists. This happened in what turned out to be almost literally a hot bed—a seminar held at the international executive centre run by Sperry Univac, the large American computer company, in the Sun-drenched South of France, not far from Nice.

Ask many people about ethics and they'll think you're talking about money and the propriety of the various ways in which you can make it. And there are certainly some ethical issues that involve finance, even for medics. As one speaker, a professor of biochemistry, put it: "People are interested in using genes to make things—insulin, interferon, money—mostly money." Say that in front of research scientists and you'll hear dissenting mutters from the audience. Scientists prefer to deny the existence of any venal motives in their activity—they do it for the good of mankind and for the sake of knowledge. But the mixed audience in Nice—never a place to forget about money—with its computer men and energy pundits could hardly deny the financial aspects of their businesses. (I leave it to you to arrive at a judgement on the financial avarice, or otherwise, of journalists.)

"Another reason why genetic engineering is interesting is that it involves sex," the professor went on. No, he wasn't there just for the laughs, and he did eventually move on to some genuine ethical issues. For example, what will we decide to do when we can repair faulty genes in people? Professor Bob Williamson—the academic with the somewhat calculated sense of humour—says that this will be possible before very long.

It makes sense to monitor the genetic make up of a fetus to see if it carries the congenital disease thalassaemia, and it probably makes sense to repair that damage. Most people—but by no means everyone—would have few qualms about such actions. But what about meddling with genes to reduce the risk of developing heart disease? After all, many people develop heart ailments because they live unhealthy lives. They can reduce their chances of dropping down dead from a heart attack by eating properly and taking some exercise. Isn't it dangerous to start mucking around with the stuff of heredity, just to save them from themselves? (Just how much impact gene juggling would have on heart disease isn't clear, but there is certainly a genetic component in such illnesses.) "I'm rather reluctant to mess around with genetics unless there is a compelling reason to do so," said Wil-

lamson. But one person's compelling reason is another person's red flag.

Heart ailments are the territory of Donald Longmore, who also made the trip to Nice. Clearly he believes that there is something ethically wrong in spending money on artificial hearts. "Every penny spent on the artificial heart is a total waste and an aberration." But what about heart transplants? Longmore once believed in these and while he doesn't disown them now he does seem to be far more interested in catching people before they need such dramatic treatment. Unfortunately, money—or rather the shortage of it—usually intervenes to render all other discussion of how to treat heart patients irrelevant: you do what you can afford to do, which, too often, isn't enough.



Ethical questions stretch beyond issues of money and what you do to people's bodies. This is where the computer men and the medics struggle to find common ground. One or two of the doctors have decided against plugging themselves into the "wired world" after listening to the computer experts.

It won't be long before it is possible to wire every home into a huge two-way communications network. Computers will, of course, control this network. They'll also be able to keep tabs on what goes into and out of each home. So the computer could keep track of what you buy with the aid of your intelligent TV set; it could also keep its version of a beady eye on the bishop who watches those naughty movies broadcast on cable television. Ian McNaught-Davis, managing director of Comshare, raised that particular question of ethics. And like all the arguments conducted in and around the swimming pool in Nice, there weren't really any answers. Even when there was something we could all agree on, it wasn't clear what should be done.

For instance, Dr John Garrow, a researcher on nutrition, convinced us all that a lot of junk is sold under the banner of "health products" but wouldn't it be an intrusion of personal freedom to deprive people of the useless pills that, they are convinced, help to control their

arthritis? Obviously, someone should stop the trade in dangerous chemicals. Call it a vitamin, charge a lot for it, and even if it is worthless, some mug will buy it. One chemical that has been banned as a drug now turns up in some mail order lists as a vitamin which it isn't. That chemical is laetile, a cyanide carrier that has killed people.

No one supports unethical behaviour like that, but no one in Nice seemed to concern themselves with perhaps the ethical issue of the week. Is it on to accept the hospitality of a large American computer company? Wouldn't some people look askance at individuals who spend a week in the South of France with the flimsy excuse that they are "attending a conference"?

Well, the speakers earned their share of Univac's hospitality. And the journalists were under no obligation to write about the meeting, let alone Univac and its computers, which weren't actually mentioned all week in any case. But would I normally concern myself with the ethical issues of computers, genetic engineering or health food if I didn't feel that I have to do something to justify that time and hospitality? Is this another one of the many unanswered ethical issues of the age? □

Healthy eating

MORE THAN ONE member of the stalwart band that assembles *New Scientist* will be on the lookout for this symbol. It tells you where you can find a vegetarian meal. More often than not, you have to find some cranky nut-

cutlet restaurant—probably bearing the name Simple Sustenance, Natural Nosh or some similarly self-righteous label. Now, thanks to the Vegetarian Society's new scheme, vegetarians might even be lured into a steak house if it offers what a vegetarian would recognise as a decent meal. This has to be something consisting of "more than limp lettuce and a few slivers of wilting tomato and cucumber, soured in salad cream", as the Vegetarian Society describes what most restaurants offer to those who ask for a meat-free meal. □



The London end of *Omni* magazine is going out with a whimper. The latest move in Bob Guccione's bid to save money—he has already "let go" his European editor—is cancellation of the party that the glossy science/science-fiction magazine was to hold at this year's annual meeting of the British Association for the Advancement of Science. We hope that *Omni* has paid for the advertisement for the magazine that appears in the programme for the meeting in Liverpool next month.

R E V I E W

A vision of an animal world**East African mammals: an atlas of evolution in Africa**

Volumes IIIC and IIID

by Jonathan Kingdon, *Academic*, pp 394 and 352, £49.95 each

The first of Jonathan Kingdon's seven volumes on East African mammals was published in 1971. Now that the final two have appeared, one may well wonder whether, at the start, the author, a young artist/naturalist still in his twenties, really appreciated how monumental a task he had set himself—to present, as he then put it, a picture and inventory of the surviving mammalian fauna of a vast area of the globe, at the same time as he illustrated the grandeur of the concept of organic evolution.

While not a professional zoologist, Kingdon did not start from scratch. He had been born in what was then called Tanganyika, and as a child had learnt to know the country and its wildlife as his parents (his father was a colonial official) moved from post to post. He was trained as an artist, and later taught art at Makerere University in Kampala, Uganda. He had not been educated in the conventional manner of a professional zoologist, so to tell the story as he wanted, he had to inform himself about the behaviour, ecology and anatomy of all the species that he was going to describe. He did this through direct observation in the field, by study of bones and muscles, by extensive reading, and by consulting far and wide with other naturalists and zoologists.

He also decided from the beginning to widen his canvas so as to provide a background of knowledge about East African mammals for those who are concerned with problems of conservation and exploitation and in order to help them understand the economic, medical and veterinary importance of the animals which were his subjects. In all these aims he has succeeded in full measure, and it might be enough to say just this, and to acknowledge and applaud the persistence of a scholar who, for near 20 years, has not deviated from his objectives.

But Kingdon has done far more than simply illustrate the concept of evolution by displaying the rich variety of East African mammals—which still represent one in five of the 900 placental mammals that are alive today. The unique quality of his *Atlas*, a quality which translates his achievement into one of

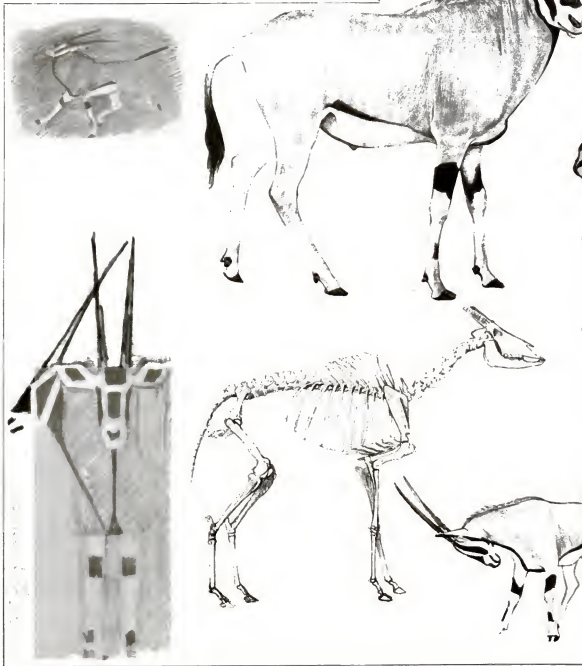
genius, is the way he has illustrated his text with drawings which, as he tells us in the preface to the first of the seven volumes, were inspired by "the contemplation of

physical beauty in mammals", something which he finds "a reward in itself". To Jonathan Kingdon drawing is a chosen way of notetaking—"the making of a drawing is not only a matter of technique for there is a constructive effort to 'figure' the animal; looking at drawings can also be an active retracing of this figuring process". For him this process means "recording" his animals in all their poses: sideways or head-on, grazing or alert, crouching or running.

The text of a conventional atlas could, one supposes, have been written by someone who, while not an artist, may have

been just as concerned as was Jonathan Kingdon to tell all he could about the habitats and ways of East African mam-

Kingdon's studies of Oryx gazella, a horse-like antelope that inhabits the deserts and dry plains of East Africa



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mals. The drawings might have been executed by an artist, say by a John Skeaping, whose imagination had been fired by the beauty of his subjects. But in all the history of zoological "atlases", I know of none where the visual impressions which animals made on the artist have enhanced so richly what it was he wanted to relate in words, or where the meaning of words has been so intensified by the vision of the artist. The medieval publishers of Pliny's and Aristotle's animal kingdoms enhanced the texts with pictures of mythical animals; Buffon with illustrations

provided by artists who had neither seen nor studied the animals which they depicted; Brehm with not very inspiring, although realistic drawings; and Grzimek with expensive colour illustrations. No one before Jonathan Kingdon has done what he has done, and told us, in the most personal visual way, with such personal understanding, what he knows about his subjects.

Both of the final volumes of the series follow the lines laid out in those by which they were preceded. They deal with the bovids and horned ungulates—the antelopes—and start by reminding us that human society is dependent on cattle, sheep and goats, because of the efficiency with which these creatures convert vegetation into "meat, milk, hide and harnessed energy". But, as Kingdon points out, "in many natural circumstances other species are demonstrably superior to livestock in the very facilities for which we value them, and there are profound ecological reasons why this should be so. Continual study of all surviving bovid species and their habitats is necessary, not because we are likely to embark on further large-scale domestication, but because we are deeply ignorant of the processes which we have shrewdly but blindly exploited all these long centuries."

He discusses, in general fashion, the origins of our domesticated species, their derivation from primitive Oligocene herbivores, and their adaptive and mutual evolution with habitats of different vegetative types, leading to the emergence of a wide variety of ecological niches and herbivore digestive tracts. He analyses different dental patterns, and speculates about the course of the phylogenetic separation of the bovids from the cervids (deer). This leads into a discussion of the separation of different genera, and so into a general discussion of sexual selection and social behaviour in the hierarchical herds in which most of the species he describes live, and of which separate and detailed accounts then follow, and which are a delight to read.

Some have said that what Jonathan Kingdon has provided is not an adequate reference book to the fauna of East Africa. One reviewer of an earlier volume complained

that what Kingdon writes about the anatomy of his animals is not a complete account of their structure and form. Some have commented that he has not been as critical in his use of "authorities" as they would have been. Obviously there may be ecologists who know more than he does about a particular species, or anatomists who know more about the skeletons of, say, primates. But it is equally true that no single man could possibly have satisfied every specialist reader, and that no specialist zoologist or anatomist could have done what Kingdon has done.

Kingdon's series of books is unique in the history of zoological literature. Many biologists have focused on a particular aspect of the living world to enrich our understanding of some special function; Kingdon has used his intellect and his skill as an artist to illuminate the wealth of a whole living world, and a living world in the round. He has reminded us that not only particular physiological functions or cellular mechanisms, but the subjects of the animal kingdom themselves, can be the material for vivid and exciting intellectual inquiry.

Solly Zuckerman

Lord Zuckerman is president of the Zoological Society of London

Women scientists

edited by Derek Richter

Macmillan, pp 219, £10

One of the commonest arguments put forward to explain the unwillingness of girls to pursue science is the lack of "role models". In other words, few women teach science, few mothers and aunts are scientists, and a list of the best-known scientists of all time would probably contain a maximum of two women. It is correspondingly hard for girls to work out what sort of person a "woman scientist" is. Derek Richter's main aim in editing this collection of autobiographies is to demonstrate what science has meant to the lives of 11 women.

But these women are a far cry from the mothers, aunts and teachers familiar to most of us. They are, as Baroness Nancy Seear points out in her conclusion, "the survivors, the fittest and the fortunate". They are chosen to represent

a variety of countries, East and West, North and South. In their countries, many were among the real pioneers of women's participation in science. Kamala Sohoni was the first woman to undertake research at the Indian Institute of Science; Chie Nakane was one of the first women admitted to the University of Tokyo (one of 16 girls out of 6000 students); and W. Muta Maathai was the first woman in East and Central Africa to receive a PhD—this was in 1971.

Needless to say, their achievements were not gained without perseverance and incredibly hard work. Kamala Sohoni's first professor expected her to work from 5 am until 10 pm, with one 2-hour break. Marian Kies trekked across the US and back in search of jobs that would not hamper the progress of her husband's career. R. Rajalakshmi left her husband and 4½-year-old son behind in India for two years when she went to join Donald Hebb's psychological laboratory in Canada.

Most of the women in the book are married and have had to divide their attention between their careers and their families. They have all become experts at this balancing act (otherwise, presumably, they would not have achieved the prominence that entitled them to a chapter in the book). But... "Of course, I always had help in the house," says one airily, and others acknowledge the invaluable support of mothers, husbands and friends in keeping things on an even keel during their careers.

So should women look to this book as a source of inspiration? Yes, if they want to see that some women, like some men, are capable of reaching dizzy heights against heavy odds. Perhaps not, if they want to learn what opportunities are available to those with no more than the usual allocations of academic excellence and true grit. But anyone should find these glimpses of lives in other cultures intriguing; the autobiographies will also be enlightening for any aspiring scientist who thinks a scientific career is a logical progression from research post to lectureship to chair.

Georgina Ferry



R E V I

A struggle for origins**Creation and evolution: myth or reality?**by Norman D. Newell, *Columbia UP*, pp 203, \$25.90

The creationist movement, dedicated to the introduction of *Genesis* into school biology classes, is today having great success in America. Although courts are proving unsympathetic to laws demanding that creationism be taught, informally creationist ideas are being sneaked into many classes and (concurrently) evolutionary ideas are getting shorter and shorter shrift.

The reasons for these creationist triumphs are many-fold. A major factor is the perceived insecurity of American society, involving such things as the rise of crime and the breakdown of the family. At times of stress people turn to simplistic comforting ideas, and the stories of the early chapters of the Bible give both a cosy picture and straightforward moral directives. But also the creationist successes ride on the failure of the orthodox scientific community to counterattack, vigorously and effectively. Creationists have won the sympathy of many, simply because professional biologists have not put their side of the case.

Times are changing. I am told that there are now some 17 books, either published or near-published, on and about creationism! With such a population explosion, the next year or so should see a fairly healthy struggle for existence. Although, to continue the bio-

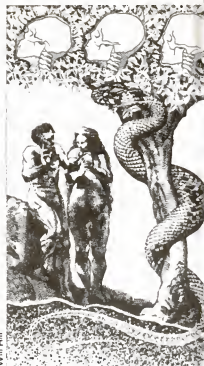
logical metaphor for a moment, no doubt different books will be adapted in different ways, thus appealing to different audiences.

One of the first of the brood has just appeared: *Creation and Evolution*, by Norman Newell, a well-known palaeontologist, who worked both at the American Museum of Natural History and at Columbia University. It sets a high standard providing a sure guide to the controversy about origins—were organisms created or did they evolve? The book is written in a clear and easy style, well illustrated with simple figures and a good choice of photographs. I loved the medieval woodcut of Noah and his Ark. The author not only knows his own subject (evolution) but also the opposition (creation). Every spurious argument (that is, every argument) of the creationists is answered in a definitive fashion. As one puts down

Newell's work, no disinterested observer can possibly still believe that *Genesis* yields the basis for a sound scientific alternative to organic descent with modification.

Following a brief history of the creationist movement, Newell turns straight to one of the major creationist claims, namely that the Earth's history shows unmistakable evidence of a recent worldwide flood. Citing one piece of evidence after another, he shows that there simply is no scientific evidence whatsoever for this claim. Fossil after fossil can be properly interpreted only in such a fashion as belies its putative marine origins. Far from being drowned in sea water, some organisms were clearly buried in the ashes from volcanic eruptions!

Moving on from the fossil record, Newell takes up the question of the dating of the Earth and its contents. There are a host of different techniques for measuring Earth's span; they all point unambiguously to an age of up to a million times in excess of the 5000 years allowed by the creationists. Nor does creationism find any comfort when we turn from the fossil world to today's living organisms. Again and again, we find evidence of evolution. As Newell notes, some of the most strik-



WILL HILL

ing phenomena are homologies, particularly the similarities between the bones of the fore limbs of man, bird, dog, whale and others. Each of these limbs serves a different purpose, and yet the bones are the same. Special creation by an all-wise designer makes no sense. Descent from a common ancestor does.

I have predicted that different evolution / creation books will probably fare differently with different audi-

From medical chemistry to biochemistry

by Robert Kohler

Cambridge UP, pp 399, £22.50

The great Otto Warburg's highhandedness and idiosyncrasy are legendary. It was he, as director of Berlin's Kaiser Wilhelm Institute of Experimental Biology, who prevented Hans Krebs from applying his methods to intermediary metabolism, directed staff to freeze out a visiting biochemist, and manoeuvred biophysicist George Wald out of the laboratory when it became clear that he had research interests slightly at variance with those of the chief.

Robert Kohler sees much more here, though, than one man's character traits. He argues that the intellectual isolation of Warburg's laboratory also reflected "systematic structural weaknesses in German biochemical institutions", with their almost complete lack of a recruitment

and reward system, and unenthusiastic commitment to discipline building. Such is Kohler's perspective as he surveys Germany and the US. He is very much less concerned with the influence of ideas and personalities in science than with processes of social and economic adaptation and competition. Science for Kohler is shaped by "its service roles in particular local contexts".

So, in Britain, we are shown that while physiologists and organic chemists in the years 1890-1920 recognised the marginal benefits of a strong biochemistry, neither were willing to support it at the expense of their own interests. Lacking an independent reward system, as in Germany, biochemistry therefore evolved only gradually and uncertainly into a quasi-independent discipline. There was nothing like the sustained nationwide reform movement which spawned a chair in virtually every medical school in the US by 1925—by which time Britain had only four.

For anyone tempted to believe (as we all do as students) that scientific specialities are fixed orders of nature, this is an enlightening book. And it gains much of its force not only from the author's determination to analyse biochemistry as a political institution, but also from his use of resources not usually tapped during the writing of science history. Above all, there is the rich lode of information in university archives, telling us why particular chairs were created and why appropriate, or inappropriate, appointments were made to them. The paramount role of academic departments is, indeed, to embody and perpetuate disciplines, so it is surprising that so few historians have exploited records of this sort in the past.

Two criticisms. First, the density and style of this book are such as to discourage many folk other than historians of science from buying or reading it. A shorter, more accessible version would un-

doubtedly be of value for scientists and indeed students. After all, analysis designed to broaden our vision of how science evolves should scarcely be restricted to other analysts.

Secondly, Robert Kohler really has gone overboard in minimising the importance of ideas and discoveries in shaping the emergence of biochemistry. It is as though a *Sunday Times* feature writer, describing the commercial emergence of big-time golf, were to ignore the skills of individual players. Strange, for example, that Kohler should say so very little about the founder of microbial chemistry, Marjory Stephenson. Aside from a brief, bald summary of her work, we are told no more than that chemical microbiology gradually became a subdepartment of the Dunn Institute, Cambridge, and that MRC established a unit devoted to the subject shortly before her death. Does not the potency of her vision deserve greater attention than this?

Bernard Dixon

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ences—I think Newell's book will appeal most to the non-professional reader.

One critical comment is that (naturally enough) Newell concentrates most heavily on the fossil record. To a certain extent, this plays into creationist hands. They too concentrate on the fossil record, arguing that it disproves evolution. Of course, it doesn't, as Newell well shows. But even talking at length about the record helps support the creationists' distorted view of evolutionary logic, namely that evolution stands and falls by the record. It does not. Fossils are but one part of the story, along with embryos, geographical distributions, homologies and much more. We must not give the creationists unfair advantage, by inadvertently letting the discussion follow their favoured form. Newell's later discussion proves beyond doubt that there is more to evolution than the fossils. I only wish he had let the reader know earlier.

But this is a grumble, not a condemnation. This is a good book to give to your students or your relatives, when they ask you if there is anything in the creationist claims

Michael Ruse

Michael Ruse is professor of philosophy and history at the University of Guelph, Ontario, and author of *Darwinism Disputed* (Addison-Wesley, 1982).

Sacred geometry

by Robert Lawlor

Thames & Hudson, pp 112,

£3-95

Sacred geometry is the study of various compass and straight-edge constructions developed in the art and architecture of Islam, Christianity, Hinduism and elsewhere, as an integral part of the whole system of religious belief. The resultant forms contrast strongly with the rectangular structures of contemporary secular culture, and generally excite even those who have no notion of the underlying metaphysics. Also, many of the geometric principles continue to be interesting in their own right, and could, for example, provide valuable extra source material for schools, stimulating a new interest in mathematics through its connection with art and cultural history. From this point of view, Robert Lawlor's book, as well as being richly illustrated, has

New Guinea tapeworms and Jewish grandmothers

by Robert S. Desowitz

Norton, pp 225, £9-95

There is more to a disease than its symptoms and mode of transmission. Yet the role of human behaviour in maintaining disease, spreading disease, preventing disease control, and even adding new diseases, has yet to receive the attention it merits. It seems we are often our own worst enemy. Ignoring long-term or indirect consequences, we dam rivers, clear forests, and encourage the flies, ticks, snails and other vectors of disease. By travel we spread diseases to new areas. Throughout the world we assume that drugs and insecticides can control diseases, so we neglect time-honoured means of hygiene and sanitation. When our chemicals fail we search for new ones and choose to ignore the consequences of our bad land-management.

This is the message from Dr Robert Desowitz's racy but charming book. Written in a light-hearted style, these fascinating "tales of parasites and people" will amuse many, interest all, and offend only those who object to occasional Americanisms in the text. One

the welcome aspect of presenting nine workbooks of construction exercises for the reader to do. I particularly liked number 7 with its novel construction of the regular pentagon and the 99-9 per cent accurate squaring of the circle.

Unfortunately, there are small errors throughout and a general failure to develop a clear and sufficient exposition of the required Euclidean principles. The bulk of the text, which provides a continuous mystical commentary, should be scrapped to make way for a more wholehearted attempt at the mathematics. I finally lost hope for the author's philosophical contributions when the originating idea of the Holy Trinity was attributed to the numbers 0.618 . . . , 1.618 . . . and 1. Compare this with the entertaining clarity of Fred Hoyle who, when examining the geometry of Stonehenge, suggested an alternative source in the Sun, the Moon and the nodal axis where their paths cross!

Robert Dixon

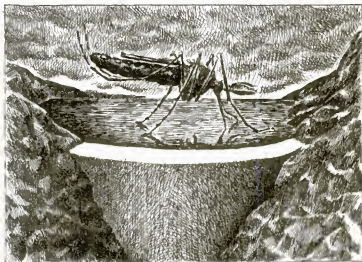


Image from Norton

feels the book could have been more forceful, considering the neglected importance of its theme, but for those who wish to explore more deeply there is a well-selected list of key references for each chapter, and an adequate index.

While rich in facts as well as anecdotes, the book succeeds in teaching a lot of parasitology. One learns not only of the titular tapeworms in the gefilte fish already, but also of anisakine worms in the sashimi (with even a recipe for it!). The important vector-borne diseases—malaria, tropical river blindness, sleeping sickness and schistosomiasis (bilharzia)—are all beautifully dealt with, as are some of the newer emerging diseases such as dog heartworm and human babesiosis on Nantucket Island. There is even a chapter discussing the possible benefit of intestinal worm infestations to asthmatics.

But this is far from a dry treatise on disease, this is a sound discussion of human ecology, ranging from primitive tribesmen in New Guinea, to rich holidaymakers in New England. Schistosomiasis, for example, is not just the story of snails and worms infesting your liver and bladder, it is the story of how a hydro-electric dam built across the Volta River changed the prevalence of the disease from 0.3 to 100 per cent in three years, and how this was repeated by the Aswan Dam in Egypt. African sleeping sickness is no longer just the story of trypanosomes and tsetse flies, but of overgrazing and climatic change leading to decreased rainfall and desertification, because cattle herds freed from the disease can in-

crease beyond the capacities of the fragile ecosystem.

Diseases, both human and animal, are not isolated cycles of cause and cure as many traditional textbooks would imply. They are aspects of whole ecosystems, intimately related to the geography and ecology of broad endemic regions in which human behaviour must be balanced with the capacity and potential of the land. Narrow approaches to specific problems can lead to disaster, like fish farms to feed undernourished Kenyans led to mosquitoes and malaria.

It seems our medical parasitology textbooks deserve some rewriting, and Desowitz's book should be required reading for our medical authors and lecturers. Many well-intentioned schemes to control diseases, alleviate poverty and generate industry have come unstuck due to inadequate understanding of human and animal behaviour within the affected ecosystem—so our scientists and administrators should read the book as well. Even the goim amongst us, who eat no sashimi, shun foreign parts and regularly pay their health insurance, should also read this "bedtime book of parasitological stories", because it will interest them, and it's fun!

Chris Schofield

Chris Schofield is a member of the Department of Entomology at the London School of Hygiene and Tropical Medicine.



R E V I E W

The last dinosaurs

by L. R. Croft

Elmwood Books, pp 80, £4-95,
pbk £2-95

A great British tradition was unfortunately broken seven years ago, when Sir Peter Scott and Dr Robert Rines regaled the media on the latest from Loch Ness, not during the approved month of August, but in November. This resulted in similar contributions to entertainment being published outside the open season. In an attempt to revert back to a noble tradition I feel that at least the review of *The Last Dinosaurs* should appear in August.

The theories of dinosaur extinction are legion and year after year one of the set theories is taken out, polished up and sprinkled with a little jargon, not too much but just enough to sound erudite. The really significant and noteworthy aspect of this book, is that it presents a completely new theory of dinosaur extinction, which would equally explain the extinction of the lizards, turtles and crocodiles which did not happen but is not able to account for the disappearance of the ammonites and phytoplankton which did.

L. R. Croft is a researcher on the role of gamma-crystallin in the formation of human cataracts and his extinction theory for the dinosaurs involves cataract blindness. This is related to the composition of the lens and derives from joint research with Dr M. B. Tabet of the Royal Manchester Eye Hospital. The amount of change in the opacity of gamma-crystallin seems to be due to the age of patients and is taken as a measure of the length of time of exposure to sunlight. Croft and Tabet showed that gamma-crystallin when subjected to heat or light becomes opaque and Croft's book proposes that the extinction of the dinosaurs was due to cataract blindness associated with global heat increase.

He also makes the suggestion that many of the structures on the heads of dinosaurs—such as those found in *Triceratops*, the duck-billed dinosaurs and the boneheads—were to protect the eyes from solar radiation. Again this is a new illuminating



A VISIT TO THE ANTELOPIAN REPTILES AT SYDENHAM—MASTER TOM STRONGLY OBJECTS TO HAVING HIS MIND IMPROVED.

theory and will delight Stephen Jay Gould and Richard Lewontin, as a modern classic of the Panglossian paradigm. It is, however, difficult to envisage how the horns and crests could have functioned as eye shades with the orientation they actually possessed.

But there is no stopping an idea whose time has come and it is striking that in 1982 there has been a Flood of data and theories all pointing to similar conclusions. There was the recent observation that the sex of reptiles in the egg was determined by the temperature and that with an appropriate rise all offspring would be male.

A group of Christian Fundamentalists, dubbed the "Scientific Destructionists", has insisted upon a literal interpretation of the fossil record. As the Rev Jesse Colson, the leader of this group, asserts: "At the end of the Mesozoic you begin to see evidence of a stunning moral decline. Bones of wives and children all alone, with the philandering husband's bones nowhere in sight. Heaps of fossilised unhatched, aborted dinosaur eggs. Males and females of different species living together in unnatural defiance of biblical law. Researchers have even excavated entire orgies—hundreds of animals with their bones intertwined in lewd positions. Immorality was rampant."

The equally serious British newspaper *The Guardian* (on 29 April, 1982), while noting "that everyone knows about dinosaurs", has remarked that "Almost nobody talks about therapists. But it was the therapists that inherited the Earth." There is now a clear

scenario emerging of a dinosaurian Sodom and Gomorrah: from the disposition of the fossils themselves, the development of single sex communities, a new and important role for the emerging therapists and the persuasively argued case that the final extinction was due to the dinosaurs going blind.

I am delighted to have this book, especially for the illustration (which is also on the cover) first published in *Punch* in 1855 and entitled: *A visit to the Antediluvian Reptiles at Sydenham—Master Tom strongly objects to having his mind improved. I do so agree with Master Tom.*

Beverly Halstead

Dr Beverly Halstead is a reader in geology at Reading University and his books include *Evolution and Ecology of Dinosaurs*.

Against biological determinism

Towards a liberatory biology

by Dialectics of Biology Group
(General Editor, Steven Rose)

Allison and Busby,

pp 184 and pp 161, £4-50 each

These two small books are both about science, but with a political purpose. They are proceedings of an interdisciplinary conference held in Bressanone, Italy in 1980 under the title, "The dialectics of biology and society in the production of mind". The opposition that the conference intended to confront is clear throughout both books, with frequent pejorative references to E. O. Wilson's *Sociobiology: The New Synthesis* and Richard Dawkins' *The Selfish Gene*.

Critiques of sociobiology and its bedfellows are by no means new, however this particular attempt does represent the transformation of this opposition to a new level. Critiques have normally adopted either or both of two simple strategies; to illustrate the inadequacies of its programme by reference to failures to explain various anomalies within nature, and/or to demonstrate the legitimacy such (pseudo?) scientific theories confer on reactionary political views. In *Against Biological Determinism (ABD)* the contributors attempt to illustrate the failure of this prevailing neo-Darwinist paradigm and its concomitant reductionist philosophy, and *Towards a Liberatory Biology (TLB)* offers an alternative model/methodology that can replace it.

The contributors are united in one belief and one fear. They are agreed that science and technology are not neutral and value-free. Rather they believe that the particular framework imposed upon science and technology from society serves the interests of late capitalism.

The shared fear is, as Martin Barker expresses it in "Biology and ideology: the uses of reductionism" (ABD), that "the trouble with modern reductionist theories is not that they are false, but that they might come true". But while the various shades of Red Experts at the conference, ranging across disciplines from philosophy to neurobiology and ethology to evolutionary biology, have a common view of the problems facing modern biology, the same cannot be said for the alternatives put forward. Almost the whole broad church of the radical science movement is represented here; the only tendency missing is the "libertarian" science is social relations school. Jonathan Cooke in "Neo-Darwinism and development biology" (TLB) seems to argue that "good" science is inevitably progressive; Steven Rose wants the dialectical approach to supersede reductionism in his "From causations to translations: a dialectical solution to a reductionist enigma" (TLB); and Mae-Wan Ho and Peter Saunders are drawn towards neo-Lamarckism in their "Adaptation and natural selection: mechanism and teleology" (TLB)—shades

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of J. D. Bernal, Friedrich Engels and T. D. Lysenko.

These two books are not the place to look for the alternative to reductionism. But they are the place to look for a number of other things; a few more threadbare patches are highlighted in sociobiological theories; and there are some illuminating individual chapters. Finally, it may well be that it is from these beginnings that an effective challenge will eventually be mounted to the current central dogma in biology. The only pity is that the authors make so few concessions to the uninitiated in their language that their message is essentially limited to a small constituency of biologists and Marxists.

Glyn Ford

Glyn Ford is a member of the Programme of Policy Research in Engineering, Science and Technology at Manchester University.

Theory and experiment in gravitation physics

by Clifford Will

Cambridge UP, pp 342, £37.50

Although the law of gravitation was most clearly seen and succinctly stated by Isaac Newton, certain aspects of it had been anticipated before him. Even Ptolemy had the vague conception of some force tending toward the centre of the Earth which not only kept bodies upon its surface but in some way upheld the order of the Universe. Johannes Kepler inferred that the planets move in their orbits under the influence of some force exerted by the Sun and two of Newton's contemporaries, Christiaan Huygens and Robert Hooke, realised that Kepler's third law of planetary motion implied the existence of a force tending toward the Sun which varied inversely as the square of the distance. Yet they could not show how this led to Kepler's other two laws of planetary motion nor could they extend their ideas to describe more specific problems like the lunar motion. Newton solved all these problems. As Byron so neatly put it, "When Newton saw an apple fall, he found . . . a mode of proving that the earth turn'd round in a most natural whirl, called gravitation, and thus is the sole mortal who could grapple since Adam, with a fall or with an apple!"

In 1915, Albert Einstein an-

nounced an extraordinary new theory of gravitation that, unlike Newton's classical theory, could successfully deal with objects moving at velocities close to that of light in enormously strong gravitational fields. This extension was achieved only at the expense of introducing considerable mathematical and conceptual sophistication; moreover, the degree to which Einstein's theory deviated in its predictions from Newton's was minute — minute but measurable. Will's monograph explains in great detail the qualitative and quantitative nature of the deviations which displaced Newton's theory (although it is such a good approximation to general relativity at low speeds that it is quite adequate for the everyday purpose of firing guns, building bridges or answering A-level questions) along with the differences between Einstein's theory and others that have arisen as outgrowths of it in recent years.

In this respect, gravitation physics is a peculiarity of the scientific method. In most, more down-to-earth disciplines, there exists an overwhelming profusion of experimental data and all manner of theoretical alternatives waiting, like Cinderella's sisters, to provide a perfect fit. Gravitation is different. Here most scientists believe we essentially have the correct theory as no rival theories even approach it in elegance and economy of ideas.

The improvement of the theory they would most like to see is the incorporation of the quantum theory into its geometrical framework. Yet during the past 20 years experimentalists have been working very hard to check the unusual predictions of Einstein's theory in natural and artificial environments. Building on the principles first outlined by Robert Dicke, Will has explained how whole classes of gravitation theory can be classified and how their multivarious predictions can be codified to narrow down the range of plausible alternatives to Einstein. In particular, he describes how to generate systematic predictions for light deflection, time-delay, perihelion shift and gives a detailed exposition of the PPN formalism.

His aim is just to provide tools which can handle new

types of theory that fall into a general class; the reader will not find in this book an exhaustive list or classification of all the hybrid gravity theories ever suggested. The author isolates just a few of the most plausible to illustrate the quantitative results generated by classical tests.

It is probably fair to say that none of these theories would exist if Einstein had not got there first. They invariably incorporate minor extensions or extrapolations of Einstein's original idea. Their viability is, in practice, gauged by the extent to which they can mimic the predictions of Einstein's general relativity which agrees with all the measurement so far made. They agree with observation only because they agree with Einstein. No theory looks radically different and yet remains in agreement with experiments.

The most detailed and valuable portions of Will's book deal with the proposed gyroscope experiments, gravitational radiation, compact objects and, most immediately, the binary pulsar. Cosmologi-

cal models predicted by alternative gravity theories receive only the scantiest treatment which is disappointing because they have, unlike the aforementioned topics, not been extensively and systematically discussed elsewhere.

The detailed level of this book and the unsatisfactory nature of the theoretical alternatives to Einstein's theory that are currently on offer and which fashion the development of Will's analysis will make it only of very specialist interest. The contents are extremely well organised and information can be readily extracted from the well-chosen charts and tables but I found the style of some sections a little awkward, most notably the introduction which reads like a collection of randomly permuted sentences! Although this is the only advanced text on the subject of experimental gravitation I think, in these days of financial stringency, even a library will have to think thrice before buying it.

John Barrow

John Barrow is a lecturer in astronomy at Sussex University.

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LETTERS

Log Ness monster

Recent articles in your journal on the Loch Ness "monster" require some comment.

Dr Maurice Burton concludes his articles (Forum, 1 July, p41; 8 July, p112) with a Partisan shot of how a correspondent of his identified an object "at the other side of the loch" as being a great northern diver and not the monster which the innocent assembled crowd took it to be. Possibly your readers are not aware that Loch Ness is about 1.5 km in width down most of its length. The head of a great northern diver is about the size of a goose's egg; it is completely impossible for anyone, save maybe Clark Kent, to see such an object with the naked eye "at the other side of the loch".

With my stalking glass, which I imagine is optically superior to Dr Burton's informant's binoculars, I think I might be able to discern a bird at the far side of the loch on a calm day in good lighting conditions, but I could not identify it. In the illustration accompanying the article the diver has had its beak amputated to make its head fit the "accepted" monster shape. In fact the massive beak of the great northern diver is one feature which bird watchers use to distinguish it from the smaller black-throated diver, which in winter plumage is rather similar. (Incidentally I hope Dr Burton's correspondent informed the Scottish Ornithological Club of his remarkable observation. The local RSPB officer tells me he has never seen a great northern diver on Loch Ness, and I myself have never, in 12 years of assiduously spying lochs in the Highlands, seen a great northern diver on any body of fresh water.) Most of the rest of Dr Burton's articles can be dismantled in a similar way, but mindful of your stricture

that short letters have better publication prospects than long ones, I shall leave it at that.

I approached Robert Craig's article (5 August, p354) with relish, thinking that here at last was the solution to the problem. Maybe it is; but scientific fact is so mixed with flippancy and gross inaccuracy that it is difficult to know if the article is even intended seriously. For example: Mr Craig states that Loch Ness "is surrounded by Scots pines". I have driven both sides of the loch hundreds of times but could not recollect any large stands of Scots pine. Much birch and Norway spruce, yes; smaller amounts of larch, rowan, sessile oak and Douglas fir; but I had always thought that Scots pine were rather lacking. However to give Mr Craig the benefit of the doubt I drove half the length (that is, about 20 km) of the loch yesterday evening. I found in total three Scots pines whose crowns, if they fell, might just be immersed in the loch.

(Incidentally your drawing in Figure 2 shows a fir or spruce and not a pine.) Can we also have a serious explanation of why a pine log should sink "somehow" to the bottom and not follow the loch's distinct surface current and float down the river Ness? *Sinclair C. Dunnett Inverness Caledonian Wildlife*

Can't people begin to leave Loch Ness alone? We all know there is something there, but how much more interesting if we are not told exactly what it is (whatever it may be) used to appear with some regularity, often to the Town Clerk of Inverness or some similar worthy, early in the tourist season. This might give one the idea that it could be a jolly tourist or bevy of tourists having a good time. Often enough, on my way north to

Inverness for meetings of the Highland Panel or the Advisory Board, I nearly saw it. Sufficiently nearly to give me pleasure and a nice break after five hours' driving. Whatever it and its fellows in neighbouring lochs may be, they are all part of Highland Nature and surely by now we have learned of the dangers of interfering with Nature! *Naomi Mitchison Campbelltown Argyll*

Robert P. Craig's suggested explanation of the Loch Ness monster is the most plausible and convincing that I have seen yet. I must admit however to a lingering trace of doubt: Can he really dismiss all the sightings of a/the creature on land as *Pinus glenmargie* or *Pinus glenivetus*? *H. J. Walls London SE22*

Mistaken identities

Maurice Burton's identification of the Loch Ness monster as an otter and/or a motorboat (Forum, 8 July, p112) reminded me of two incidents which happened in Yellowstone National Park several years ago. My son and I noticed a group of people excitedly pointing to something on an open, grassy slope, in broad daylight, about a quarter mile off. At least half of these two dozen folk were using binoculars, and all were talking about the grizzly bear they were observing. Actually, the beast was a large bull buffalo (*Bison*), complete with horns and tail. Within a half-hour of this, we were some miles away from the *Bison* when we stopped to photograph a waterfall. A man was telling his children, at this stop, to look at the two bear cubs playing on a log up the slope about two hundred yards away. We identified these petite beasties as two common ravens,



probably arguing over a scrap of food.

Having been brought up near the Bronx Zoo in New York City, I had fancied that even big-city folks would know a buffalo from a bear—and, certainly, a bear from a raven—but this is obviously not the case.

*Robert G. Schiff
University of Montana
Missoula, Montana*

Stuff paradigms

I read with considerable if somewhat sour amusement your adulation of Thomas Kuhn and his work (*Revolution in Science*: 20 years on, 5 August, p372.) Could anything better display the utter vacuity of almost all of what passes for "philosophy"?

Any man who has studied the history of any science is well aware that it is characterised by rather long periods of comparatively slow progress punctuated by briefer periods of rapid progress. Further, only a little thought is needed to see why this is generally to be expected. Let someone dress up these sufficiently obvious matters in rebarbative neologisms ("paradigm shift" etc.) enshroud them in some hundreds of pages of insipid prose, and he is hailed as a

Bill Tidy

Grimbledon Down



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APPOINTMENTS AND SITUATIONS VACANT

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A vacancy exists in the institute's Safety Section for a technician to assist with the routine commitments of the Section, to dispense radioisotopes and to manage the radiochemistry laboratory. The successful applicant will be expected to show an active interest in safety and to become involved in all aspects of the Section's work. In addition the post-holder will assist the Fire Officer in his duties. Experience of handling radioisotopes is desirable but not essential. Applicants should have a degree or equivalent in a science subject.

The starting salary depending on age, qualifications and experience will be in the range £5515 to £7550 inclusive of London Weighting.

Please telephone for an application form on 01-959 3666, extension 218, or write to Mr G. J. Smith, Assistant Personnel Officer, NIMR, The Ridgeway, Mill Hill, London NW7 1AA. Quote ref PF/F.

Medical Research Council

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This is a key management appointment with one of the country's leading manufacturers of soft drinks. The successful candidate, who will be responsible to the Technical Manager, will lead a small team engaged in the development of new products, processes and analytical methods as well as the continuous assessment of existing lines. Work will involve close liaison with other Company functions such as production, marketing, sales and purchasing as the development team are involved in projects from inception through production and marketing trials to launch.

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Write with details of experience to John Harrison, Personnel Manager (South), Britvic Limited, Britvic House, Broomfield Road, Chelmsford, Essex.

Closing date: 31 August, 1982.

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THE UNIVERSITY OF LEEDS DEPARTMENT OF PHYSICS

Applications are invited for a post of postdoctoral

RESEARCH FELLOW

in the above department to undertake studies of the failure of polymers at high pressures. Candidates should have a degree or equivalent qualifications in Physics, Engineering or Materials Science; and preferably a PhD or relevant industrial or other experience. Experience in testing and development would be particularly valuable.

Salary within the IA Range for Research and Analogous Staff (£6070-£10 575) (under review) according to age, qualifications and experience.

Informal enquiries may be made to Professor I. H. Ward, Department of Physics (tel. Leeds (0532) 437751 ext. 7118).

Application forms and further particulars may be obtained from The Registrar, The University, Leeds LS2 9JT, quoting reference number 52/22/E. Applications should be submitted as soon as possible.

SALFORD HEALTH AUTHORITY

Willink Biochemical Genetics Unit
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 Hospital Road, Pendlebury, Manchester M27 1HA

Basic Grade Biochemist

The Unit is the Regional Amino Acid Reference Centre and is responsible for the Regional Phenylketonuria screening programme and for the investigation of a wide variety of inherited metabolic diseases, e.g. organic acid disorders, lipid storage diseases by lysosomal enzyme assay, disorders of galactose metabolism and mucopolysaccharidoses.

Applicants should possess an appropriate science degree or equivalent qualifications. Experience of biochemical and chromatographic techniques will be an advantage.

Salary scale: Probationer (with appropriate science degree) £5667-£6745 per annum. Post-probationer £5886-£7537 per annum.

A job description and application forms available from the Administrator at the above hospital telephone 061 794 4696 ext. 137. Informal enquiries to the Unit: tel. 061 794 4696 ext. 312.

Closing date for applications 31 August, 1982.
 Please quote reference P&T1/KBCB.

UNIVERSITY OF BRISTOL DEPARTMENT OF BIOCHEMISTRY

RESEARCH ASSISTANT

A graduate Research Assistant (1b) is required for an SRC funded research project on the mechanism of DNA-protein interactions. The research will involve molecular genetics as well as both DNA and protein biochemistry. Applicants should possess a BSc or equivalent in either Biochemistry, Microbiology or a related subject.

The post is available for a three year period starting from 1 September, 1982, or as soon as possible thereafter. The initial salary will be £5,285 (under review). Applications, including a brief curriculum vitae and the names and addresses of two referees, should be sent to Dr S. E. Halford, Department of Biochemistry, University of Bristol, Bristol BS8 1TD.

NATIONAL CENTRE OF SYSTEMS RELIABILITY SYSTEMS ENGINEERS

Two Professional Engineers with theoretical and practical experience of reliability technology are needed by the Research and Technology Transfer Unit of the NCSR (part of the Safety and Reliability Directorate of the UKAEA located at Culcheth near Warrington in Cheshire).

THE JOBS

The role of the NCSR is to develop, and make available on a commercial basis, expertise in the reliability assessment of systems and components, e.g. integrity of electrical supply and distribution systems and failure modes and effects in control systems. The Centre operates a Data Bank containing Event and Reliability Data Stores, and provides a consultancy and information service to industry and Government departments, including a confidential project service to give a quantified assessment of the reliability of particular systems.

Post 1 will be concerned with advancing reliability analysis techniques – in particular, stochastic simulation of large systems – for dealing with problems of uncertainty in complex systems not tractable by conventional analytical techniques. There are demands for producing robust methods for direct application by reliability assessment engineers, and for co-operating with specialists in human reliability factors and data processing.

Post 2 will be concerned with assessing the needs of industry for specialist courses aimed at reliability technology transfer on such topics as fault tree analysis and failure modes and effects analysis; and then planning, developing, and operating a range of courses, symposia and conferences. Some lecturing will be included. Co-operation with other specialist safety and reliability technologists is an important part of the work.

Further details of the posts will be sent with the application form.

WHAT YOU NEED

Applicants (men or women) should hold an Honours Degree in Engineering, Physics, or a related discipline, or Corporate Membership of a relevant Senior Professional Institution. They should have several years' experience appropriate to the work.

THE REWARDS

Appointments will be as a Professional and Technology Officer Grade 1 (Salary range £10,350 – £12,445 per annum), depending on background and experience.

Benefits include a contributory superannuation scheme and there are good career prospects.

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The Directorate is at Culcheth near Warrington in Cheshire. The area features good schools, convenient motorway links, easy access to main centres in the North West and a wide variety of housing. Assistance may be given with house purchase or removal, or single accommodation can be made available.

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Address

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Closing date for applications 1st October 1982

Send to: PERSONNEL DEPARTMENT, FREEPOST,
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SAFETY AND RELIABILITY DIRECTORATE,
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Department of Physics
Four posts are available from
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(postdoctoral or equivalent experience) required for a period of 2½ years. The post is supported by the Science and Engineering Research Council and is to study the reconstruction of three-dimensional images from sampled data. The work has particular relevance to electron and acoustic images. Candidates should have experience in the general area of scattering theory and computational image analysis.

Salary (aged 26) £7225 plus London allowance £1035.

RESEARCH ASSISTANT

(postdoctoral or equivalent experience) required for a period of one year in the first instance but with planned extension to three years, on government funds, to consider theoretical and computational aspects of image extraction and pattern recognition. Requirements as above.

Starting salary according to age and experience in range £7225-£8940 plus £1035 London allowance.

RESEARCH ASSISTANT

(postdoctoral or equivalent experience) supported for three years by funds from the Medical Research Council. A Physicist is required with background in signal/image processing preferably within a medical application. The Assistant will be on the analysis of ultrasound images as produced in paediatrics. He will co-ordinate the study with Professor V. Dubowitz of the Department of Paediatrics and Neonatal Medicine at the Hammersmith Hospital and have primary responsibility for image assessment and interpretation.

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COMPUTER PROGRAMMER

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Applications with details of two referees, should be sent by 8 September to Professor R. E. Burge, Physics Department, Queen Elizabeth College, Camden Hill Road, London W8 7AH.



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Applications are invited for a three year SERC RESEARCH ASSISTANTSHIP to study microstructural developments in stainless steels during low-cycle fatigue in fusion reactors.

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POSTDOCTORAL RESEARCH ASSISTANT

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Salary on the IA scale £6375-£11105. For further information phone or write to Dr G. A. Codd, Department of Biological Sciences, The University, Dundee DD1 4HN, Telephone Dundee 23181 Ext 326.

Applications, in writing, including the names of two referees should be submitted to the Personnel Officer, The University, Dundee DD1 4HN as soon as possible. Please quote Reference EST/47824.

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Department of Biology

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Biochemistry**

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Applications are invited for the above posts. The successful candidates will be responsible to the Chief Technician, Biology, for the preparation for HNC and degree level classes and with post graduate research and other duties.

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AN INFORMATION OFFICER

is required to join the Section providing scientific information services at the Institute.

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Ware: Herts

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Chemical and Biochemical Engineering Department
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MEDICAL RESEARCH COUNCIL

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Qualifications: Degree, HNC or equivalent.

Salary according to age, qualifications and experience in the range of £4958-£6993 plus London Weighting of £557.

Apply in writing, giving the names and addresses of two professional referees to: The Director, Laboratory Animals Centre, MRC Laboratories, Woodmansterne Road, Carshalton, Surrey SM5 4EF.

MRC

Medical Research Council

QUEEN MARY COLLEGE University of London

Materials Department
A POSTDOCTORAL RESEARCH ASSISTANTSHIP is available for one year from as soon as possible, to work on a project on novel metal matrix composite material, under the direction of Professor W. Bonfield. Salary in range £6670 to £10 375 per annum, plus £1035 London Allowance. Applications should be sent to Miss M. Elmslie, Queen Mary College, Mile End Road, London E1 4NS, enclosing a curriculum vitae and nominating two referees.

UNIVERSITY OF LEICESTER

Department of Chemistry
A TECHNICIAN, GRADE 3 is required in the Department of Chemistry to assist with the operation of Nuclear Magnetic Resonance Spectrometers, providing a service to the whole department. Training will be given. Minimum qualifications required: ONC/TEC or two "A" levels including chemistry. Salary £4672-45473 a year (under review). Applications, giving full details, should be sent to Mr H. T. Whit, Department of Chemistry, The University, Leicester LE1 7RH, from whom further details can be obtained.

UNIVERSITY OF BRISTOL DEPARTMENT OF PHYSICS

LECTURESHIP IN PHYSICS

Applications are invited for a Lectureship in the Department of Physics, financed initially by the Science and Engineering Research Council under its Special Replacement Scheme. The conditions of service, including probation, are the same as for other lectureships within the University. Initial salary will be within the range £6070-£10 160 of the Lecturer scale.

The successful candidate will be expected to engage in a programme of experimental research within the Electron Microscope Group led by Dr J. W. Steeds. The interests of this group include electron diffraction, cathodoluminescence, and low temperature phase transitions, and a number of projects are carried out in collaboration with industry. Preference will be given to candidates with an interest in developing instrumentation for transmission electron microscopy. Further particulars may be obtained from the Registrar and Secretary, University of Bristol, Senate House, Bristol BS8 1TH, to whom applications should be sent by 17 September, 1982 (please quote reference E.B.).

PLANT BREEDING INSTITUTE, Maris Lane, Trumpington, Cambridge CB2 2LQ

A suitably qualified person is required to develop and use the methods of in situ hybridisation to study the location of particular DNA sequences in plant chromosomes particularly those of cereals. The aims of this programme will be to exploit these techniques in cytological and general studies as well as in the identification and manipulation of genes and chromosomes particularly those of cereals. The results of this work will also provide information about the organisation of repetitive DNA within cereal chromosomes and their role in determining chromosome behaviour and other nuclear genetic plant phenotypes. The work will be involved closely with existing programmes in wheat cytogenetics and molecular genetics. Appointment will be at Higher Scientific Officer (salary £6840 to £9136 p.a.) or Senior Scientific Officer (salary £8599 to £10967 p.a.). Non-contributory pension scheme.

Qualifications are a First or Upper Second Class Honours degree in an appropriate biological science and seven years postgraduate experience in plant cytogenetics or related research for MSc, and 4 years for SSO.

Applications with curriculum vitae, together with the names and addresses of three referees, should be sent to the Establishment Officer by 10 September, 1982.

Please quote Reference CXT/139.



Southampton THE UNIVERSITY

EXPERIMENTAL OFFICER - NEUROSURGICAL GROUP

Applications are invited for the post of Experimental Officer for three years to provide technical support for the postgraduate programme of the Neurosurgical Group, in particular to complete development of the water-restricting and physiological monitoring techniques for the measurement of cerebral blood flow and metabolism. Salary on scale: £6880-£7700 per annum plus US\$ benefits. Proposed starting date: 1 October 1982. Applications (in duplicate) giving a brief summary of the water-restricting and physiological monitoring techniques for the measurement of cerebral blood flow and metabolism, should be sent to: Mr A. J. Small, The University, Southampton SO9 2NH, quoting reference 1234 A.S.

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Write to Squadron Leader P Kilburn, BSc, RAF Officer Careers (609TK/3), London Road, Stanmore, Middlesex HA7 4PZ, or call in at any RAF Careers Information Office.

Please include your date of birth and your present and/or intended qualifications. Upper age limit on entry is 39.

Formal application must be made in the UK.

Education & Training



RAF Officer

MEDICAL PHYSICS TECHNICIAN III (Clinical Measurement)

Department of Medical Physics
and Clinical Engineering

An experienced technician is required to co-ordinate the electrodiagnostic service provided by the clinical measurement section of the department based at the Leicester Royal Infirmary.

The major interests of this work include the testing of auditory evoked responses and vestibular function, ophthalmic electrodiagnosis and evaluation of visual fields, paediatric auditory and speech tests, and a calibration service for Leicestershire's audiometres.

Applicants should possess HNC/ONC (or equivalent) in an appropriate subject and three years experience in this field of work.

Salary £5536-£7155 (under review). New entrants to the National Health Service will normally commence at the minimum point on the scale.

For further information telephone Leicester 541414 ext 5486 and ask for Mr Bentley.

Application forms and job descriptions are available from the Personnel Department, Leicester Royal Infirmary, Infirmary Square, Leicester LE1 5WW. Telephone Leicester 541414 ext 5137/8 between 9am and 5pm.

Closing date for applications: 7 September, 1982.



Leicestershire Health Service

Information Scientist

The Information Services Section provides library and information services to the research and development laboratories in the U.K. and abroad responsible for cosmetics, toiletries, food, drinks, proprietary medicines and adhesives.

There is a vacancy at Leatherhead for an Information Scientist with a scientific background. Duties will include scanning of publications for current awareness bulletins and the preparation of bibliographies using manual and on-line sources.

Candidates should be recent graduates with experience of, or an interest in, industrial information work.

Flexible working hours and non-contributory pension apply.

Apply in writing, giving full details of career to date to:—The Senior Personnel Officer, Beecham Products, Research Department, Randalls Road, Leatherhead, Surrey, KT22 7RX.

Beecham Products





Quality Assurance Auditor — Biologicals

£8,100 — £11,600

Beckenham, Kent

The Wellcome Foundation Limited, a major British-owned pharmaceutical company, is strengthening its activities in the field of biotechnology.

As part of this development we wish to further expand our efforts in the important area of Quality Assurance auditing. We are seeking an experienced microbiologist to join a small specialist team with responsibility for monitoring our Production and Quality Control activities and ensuring that they conform with Company standards and regulations relating to Good Manufacturing Practices.

Candidates will hold a degree in microbiology or equivalent, will preferably be experienced in the production of biologicals and ideally have experience in the specialised field of Quality Assurance auditing and GMP.

Although based at Beckenham, Kent, there will be a requirement to undertake short-term assignments overseas from time to time.

Excellent benefits include 5 weeks' holiday, life assurance and pension schemes, subsidised restaurant, first class sports and social facilities and generous assistance with relocation expenses where appropriate.

Please write with full details to Peter Anderson, Personnel Officer, The Wellcome Research Laboratories, Langley Court, Beckenham, Kent BR3 3BS. Applications must be received by 27 August and interviews will be held on 6 and 7 September.



Wellcome

UNIVERSITY OF NEWCASTLE UPON TYNE Department of Occupational Health and Hygiene JUNIOR RESEARCH ASSOCIATE

Applications are invited for a temporary post as Junior Research Associate to join a team investigating long term respiratory and cardiovascular function in relation to occupation. Candidates should have a good degree in physiology, applied human biology, or a related subject, and should have an interest in computing/statistics. The post is available from 1 September, 1982, to 29 February, 1984. Commencing salary up to £5675 per annum on the Range 1B scale £5285-£7700 per annum.

Applications giving full curriculum vitae and the names of three referees should be sent to Dr J. E. Cotes, Department of Occupational Health and Hygiene, The University, 24 Claremont Place, Newcastle upon Tyne NE2 4AA, to arrive not later than 6 September, 1982.

THE UNIVERSITY OF HULL DEPARTMENT OF ZOOLOGY

RESEARCH TECHNICIAN Grade 3 or 4

Duties: Morphological and physiological investigations into the developing cerebrospinal fluid system in the rat.

Requirements: ONC or equivalent plus at least three years experience.

Conditions: Fifteen month contract; salary in excess £4000-£5000, £3600-£4000.

Applications: To the Personnel Office, The University of Hull, Hull, HU8 7RX, by 28 August, 1982.

Analyst £4,800 p.a. Pharmaceutical Manufacturer

A recently qualified Graduate, BSc Honours—Chemistry, is required for our Quality Control Laboratory. The position will involve carrying out analysis of finished products and raw materials.

This is an ideal opportunity for someone wishing to commence an analytical career.

Interested men or women should apply with full career details to The Personnel Department:



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BRISTOL POLYTECHNIC SCIENCE DEPARTMENT

Applications are invited for the following post

SENIOR TECHNICIAN, CHEMICAL PLANT TECHNOLOGY

Ref No T/21

SALARY SCALE: £5652-£7137 per annum.

The successful applicant will be responsible for the organisation and maintenance of pilot scale work in the Chemical Plant Technology Laboratory at our Ashley Down site.

Applicants should have qualifications to at least Ordinary National Certificate or City and Guilds Ordinary Technician (both now OTEC) standard. Previous laboratory experience is essential, preferably involving the use of computer or microprocessor linked equipment.

It is possible that this post will shortly be relocated at Goldharbour Lane, Bristol. For further details and an application form, to be returned by 30 August, 1982, please contact the Personnel Office, Bristol Polytechnic, Goldharbour Lane, Frenchay, Bristol or ring Bristol 454241, Ext 575. Please quote Reference Number T/21 in all communications.

UNIVERSITY OF BATH School of Chemistry TECHNICIAN

A vacancy exists for a Technician to assist in the Physical Chemistry Laboratories. Duties will include the preparation of materials and equipment for under-graduate practical classes, and the operation and maintenance of basic laboratory instruments and research equipment. Some previous experience in science laboratory work necessary. ONC, HNC, or equivalent qualification is required.

Salary in the range of £4672-£5473 per annum (under review) according to qualifications and experience.

Application forms from the Personnel Officer, University of Bath, Bath BA2 7AY, quoting ref no: 82/87. Closing date: 1/9/82.

Pharmacist

-Pharmaceutical Formulation

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The Boots Company is a complex international group with worldwide sales exceeding £1400 million. One of our particular strengths is the research, development and manufacture of ethical and proprietary medicines for the U.K. and international markets.

An interesting career opportunity has arisen within our Pharmaceutical Formulation Department for a registered Pharmacist - who will be involved in the development and optimisation of formulations and processes for a wide range of dosage forms.

The position would suit those who have recently registered who are seeking to commence or extend their career in this challenging area of industry. Applicants will need to have an open mind, be innovative, with good communication skills and a willingness to learn. Full training will be given to candidates with no previous industrial experience.

The benefits are those you would expect of a large company with a substantial international reputation - staff purchase privileges, profit related bonus and contributory pension scheme. Generous help with relocation is available if applicable.

Please write or telephone for an application form to: Tom Flower, Employment Manager (Technical), The Boots Company PLC, Station Street, Nottingham NG2 3AA. Tel: (0602) 56255 Ext. 243.

POLYTECHNIC OF THE SOUTH BANK
Borough Road, London SE1 6AA
DEPARTMENT OF
ELECTRICAL AND ELECTRONIC ENGINEERING

SENIOR LECTURER/LECTURER GRADE II (3 posts)

(Ref: E.7)

Applications are invited from well-qualified engineers with recent industrial/consultancy/research experience. Two posts are permanent; the other is temporary with possibility of repeated extension.

The Department is currently operating industrially orientated undergraduate and higher technician courses, together with an expanding postgraduate school. An MSc course in CAD/CAM is to commence in January 1983. The successful candidate will be likely to hold a postgraduate degree or come directly from industry, having expertise in such areas as computing, micro-electronic applications, telecommunications or process control.

Salary will be in the range:

Senior Lecturer: £10 932-£13 575 per annum inclusive of London Allowance.
Lecturer Grade II: £7614-£11 781 per annum inclusive of London Allowance.

RESEARCH ASSISTANT in CAD/CAM

(Ref: R.A.11)

Applications are invited from graduates holding a good Honours degree in Electrical/Electronic Engineering, Physics, Mathematics or another relevant discipline. The successful candidate would join a well-established team and undertake postgraduate research into methods for designing complex digital microelectronic systems.

Salary will be in the range: £5439-£6114 per annum inclusive of London Allowance.

Further particulars and application form available from the Staffing Office. Telephone: 01-928 8999 ext. 2355.

Completed application form to be returned no later than 3 September, 1982.

PART-TIME LECTURERS

Opportunities exist for well-qualified electrical/electronic engineers who have relevant industrial/academic experience and would wish to undertake part-time teaching. Those interested should please write directly to: Mr R. Arney, Principal Lecturer, marking the envelope "PART-TIME TEACHING"

Biochemical Pharmacologist

Smith Kline & French Research Limited is the UK based Research Group of the international SmithKline Corporation. We have recently moved to a new 39-acre site at The Frythe near the village of Welwyn, as part of a considerable expansion programme based on a very promising research portfolio. This new facility represents a major investment and underlines our commitment to pharmaceutical research and development.

A vacancy has arisen for a graduate in biochemistry or pharmacology to join our CNS research group. The successful applicant will be expected to develop and use biochemical systems to study pharmacological aspects of interest. Applications are invited from recently qualified graduates and from graduates with experience in biochemical approaches to pharmacological studies.

We offer highly competitive salaries on progressive incremental scales and a discretionary end-of-year bonus. Other benefits include free life assurance, an excellent contributory pension scheme, free membership of BUPA and flexible working hours.

Please telephone or write for an application form, quoting ref no. NSC/164, to Marie Algar, Recruitment Administrator.

SMITH KLINE & FRENCH RESEARCH LIMITED

Research Institute, The Frythe, Welwyn, Herts AL6 9AR

Tel. Welwyn Garden 25111 ext. 3541

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THE UNIVERSITY OF MANCHESTER

Simon Engineering
Laboratories

RESEARCH ASSISTANT

The civil engineering team studying the behaviour of composite vessels subjected to external pressure for sea-bed oil production and other applications seeks a research assistant with a degree in engineering or physics and preferably some experience in experimental research. Salary range per annum: £5285-10 575 funded by SERC through the NW Universities Consortium for Marine Technology for one year in the first instance. The appointee may be able to register for a higher degree. Applications by 11 September, including the names of two referees, to Dr P. Montague, Simon Engineering Laboratories, The University, Manchester M13 9PL, from whom further details may also be obtained.

ST GEORGE'S HOSPITAL MEDICAL SCHOOL

(University of London)

TECHNICIAN 3

required for three-year MRC sponsored project in the Biochemistry Department concerned with the behaviour of specific cell types derived from the human ovary tissues. Experience in tissue culture useful but not essential. Initial salary up to £4835 per annum (under review) plus £464 per annum London allowance. Application form available from The Establishment Officer, St George's Hospital Medical School, Cranmer Terrace, London SW17 0RE.

UNIVERSITY OF LIVERPOOL

Department of Immunology
TECHNICIAN GRADE 3

to assist in grant-funded investigation of transfusion effect in patients awaiting kidney transplantation. Candidates must possess ONC or equivalent as minimum qualification plus three years' experience. Previous experience in cellular immunological techniques would be an advantage.

Post available for two years initially. Salary within range £4072-£5066 per annum.

Application forms may be obtained from the Registrar, The University, PO Box 147, Liverpool L69 3BX. Quote ref RV/780/NS.

UNIVERSITY OF GLASGOW RESEARCH ASSISTANT

A science graduate with a good honours degree is required as a research assistant to study the synthesis and degradation of complement receptors on different types of peripheral blood cells. The post has been created by a three-year grant from the Arthritis and Rheumatism Council. There is opportunity to study for a higher degree.

Salary will be within £5285-£6070 on Range 1B of the scales for Research and Analogous staff.

Applications, with names and addresses of two referees, to Dr K. Whaley, Department of Pathology, Western Infirmary, Glasgow.

In reply please quote ref no: 4915N.

Graduate Physicist for Construction Materials R&D

Redland Technology is a member of Redland PLC a multinational Group which is principally concerned with the manufacture of building and construction materials.

A young graduate physicist is required to join the Section operating the Company's Wind Tunnel Testing facility.

The work entails the design and construction of tests rigs, principally concerned with roofing products; the operation of tests, monitoring results and the preparation of reports.

After an initial period the successful applicant will be required to assist the Section Leader by representing the Company at B.S.I. and other relevant committees including discussions and negotiations with the Group's relevant manufacturing divisions.

Experience is not necessary as training will be given. Starting salary will be between £5,000 - £5,500 according to age and qualifications.

This post carries the benefits you would expect to be found in a major industrial group, including 25 days annual holiday, contributory pension scheme, generous sick pay scheme, and good prospects for promotion both within the company and the group. Redland Technology is situated in the country on the outskirts of Horsham. There is a subsidised canteen on site, company transport to and from Horsham town.

Please telephone, reversing the charges for an application form and further details of this vacancy, or write to Mr. R. A. G. Poulton, Personnel Manager, quoting vacancy ref. 7/82 at Redland Technology Limited, Graylands, Horsham, Sussex. (Horsham 50222).

Redland Technology

NORTH EAST THAMES REGIONAL HEALTH AUTHORITY TRAINING SCHEME IN MEDICAL PHYSICS

This Authority, in co-operation with the University of London, invites applications from physicists for this training post offering the opportunity to study for the MSc degree in medical radiation physics, or medical electronics.

The person appointed will undertake a programme of in-service training under the general direction of the Regional Scientific Officer and study for the degree by means of a two-year day release course commencing in September/October 1982. The successful candidate may also be able to join the Hospital Physicists' Association four year training scheme.

Applicants should have a good honours degree in the appropriate subject acceptable to London University for MSc registration.

The probational salary scale is £5667 rising to £5745 per annum (plus London Weighting where applicable).

The successful applicant will be expected to meet the cost of the MSc course registration and examination fees (currently about £350 per annum).

Application forms and further details available from the Personnel Department, North East Thames Regional Health Authority, 40 Eastbourne Terrace, London W2 0LZ. Tel: 01-262 8011 ext 143. Please quote ref: 4023.

Closing date Friday, 3 September, 1982.

MRC CLINICAL RESEARCH CENTRE (NORTHWICK PARK HOSPITAL) WATFORD ROAD HARROW, MIDDX HA1 3UJ

TECHNICIAN

A Technician is required to work within the division of psychiatry assisting in a project involving the growth of neurotropic viruses both in cell culture and in vivo. Also involved would be techniques concerned with radio-labelling, purification, WDA hybridisation, use of anti-viral agents and lymphocyte cultivation. Previous experience in Microbiology, Virology or Biochemistry would be an asset.

Salary will be within the range £5515-£7550 (inclusive of London Weighting) depending on age and experience.

For application form and further details apply in writing please to Miss B. Shaw, quoting Ref: 125/2/4260. Closing date 31 August, 1982.

INSTITUTE OF ZOOLOGY ZOOLOGICAL SOCIETY OF LONDON

LABORATORY TECHNICIAN

required to assist in a research programme in mammalian reproductive physiology. Experience in radioimmunoassay techniques is essential; knowledge of reproductive endocrinology and/or biochemistry would be advantageous.

Candidates should possess or be working towards an HNC, BSc or comparable qualification. The appointment is for 3 years initially. Salary, according to age, qualifications and experience, to be within the range £5085 to £6345 plus including London Weighting.

Applying in writing, giving full details to the Establishment Officer, Zoological Society of London, Regent's Park, London NW1 8RT.

IMPERIAL CANCER RESEARCH FUND

SENIOR OPERATOR DEC 20/60

required by our Research Computer Unit for a nine months appointment. The Unit provides the Computer service for the scientific work of the Fund, and we require a person conversant with scientific time-sharing system operations, a good knowledge of BASIC or FORTRAN and experience in Assembly level work. Salary range £6045 to £8080. For further information and application form write or telephone Ms S. M. Hurley, Imperial Cancer Research Fund, Lincoln's Inn Fields, WC2A 3EX on 242-5200 ext 365 quoting ref. 111.82.

PUBLIC HEALTH LABORATORY SERVICE BOARD

PHLS Centre for Applied Microbiology and Research MEDICAL LABORATORY SCIENTIFIC OFFICER VACCINE RESEARCH AND PRODUCTION LABORATORY

Applications are invited for the above post in the Vaccine Research and Production Laboratory at the Centre for Applied Microbiology and Research. The Laboratory is involved in investigations of micro-organisms of current or potential clinical importance and the production of human vaccines and diagnostic reagents against a range of pathogenic micro-organisms under the appropriate licensed conditions.

The successful applicant will be expected to (a) be involved in the research programmes within the laboratory, in particular those leading to the development of effective herpesvirus vaccines, and (b) assist when necessary in the manufacture and testing of microbial vaccines for clinical use.

Applicants should be registered with the Council for Professions Supplementary to Medicine or be a graduate in an appropriate field, eligible for State Registration. Possession of a sound knowledge of microbial and tissue culture techniques is essential and an understanding and interest in biochemistry would be desirable.

Starting salary for MLSO grade: £4558 per annum, rising by annual increments to £5600 in 1983. £6993. National Health Service Terms and Conditions will apply. The post may be disclosed informally by contacting Dr C. N. Wible, telephone Idmiston 08361.

Application forms are available from Mrs M. Bushby, Personnel Officer, PHLS Centre for Applied Microbiology and Research, Gordon Down, Salisbury, Wiltshire SP4 0JG. Tel: Idmiston 610331. Closing date 3 September, 1982.

UNIVERSITY OF ST. ANDREWS Department of Physics

Applications are invited for a post of

POSTDOCTORAL RESEARCH FELLOW

tenable for up to three years at a salary in the range from £6070 to £6880 (under review). The project is SERC-funded and involves the application of double nuclear resonance techniques to the synthesis and characterisation of extremely dilute impurities in semiconductors of commercial interest. Good knowledge of the techniques will be used.

Some experience of *s.f.* and cryogenic techniques desirable. Starting date negotiable in the range from October 1982 to October 1983.

Further details are available from Dr D. D. Turner, Lecturer in Physics, St. Andrews University, North Haugh, St. Andrews KY16 9SS, to whom applications with a curriculum vitae and the names of two referees should be sent as soon as possible.

UNIVERSITY OF READING Department of Food Science POSTDOCTORAL RESEARCH OFFICER

required for a fixed period of three years from 1 October, 1982 to work on ARC funded project on the development of chromatographic methods for the determination of food triglycerides.

Applicants should possess a sound knowledge of modern chromatographic methods and a strong interest in the development of food analysis. Starting salary £6375 per annum. USS superannuation. Applications, together with curriculum vitae, should be sent to Personnel Office, University of Reading, Whiteknights, Reading RG6 2AH. Tel: 0734-875125; ext 233.

**QUEEN ELIZABETH
COLLEGE
Kensington
(University of London)
Food Science and Nutrition
Department
TUTORIAL ASSISTANT**

A part-time (2/3 days/week) tutorial assistant is required for the postgraduate University of London Diploma Course in Food Resources related to Community Development, taught at Queen Elizabeth College in the Department of Food Science and Nutrition. A degree in sociology/social anthropology together with background knowledge in Community Development and experience in a developing country such as VSO are desirable. The person appointed will be expected to undertake some administration duties and deal with the secretarial and organisation problems of the course. The appointment would initially be for 12 months from 1 November, 1982 or as soon after as possible. Salary for full-time in range £3375-£3840 per annum plus London allowance £1035 per annum; pro rata for part-time. London allowance, also pro rata, in addition.

Further particulars and application form from the College Secretary, Queen Elizabeth College, Campden Hill Road, Kensington, London W8 7AH. Tel: 01-837-5411; ext 269.



**Southampton
THE
UNIVERSITY**

MICROELECTRONICS CENTRE

Applications are invited for:

**PROCESS
ENGINEERS/
ASSISTANTS**

In semiconductor device fabrication to work in the Centre's extensively equipped fabrication facility. An increase in industrially sponsored work has led to these vacancies. In addition to MOS and bipolar integrated circuit fabrication, the person appointed would become involved in the development of new transducers in silicon, and would have the opportunity to develop higher skills in silicon processing.

Experience of fabrication is essential and a knowledge of semiconductor physics would be advantageous.

Salary dependent upon age, experience and qualifications.

Applications (in duplicate) should be sent to D. A. S. Copland, The University, Southampton SO9 5NH, giving a brief curriculum vitae and the names of two referees, quoting reference 336/A/NS.

**UNIVERSITY OF
LIVERPOOL**

**Department of Biochemistry
RESEARCH ASSISTANT/
SENIOR RESEARCH
ASSISTANT**

Applications are invited from graduates in biological sciences for the post of Research Assistant/Senior Research Assistant in the Department of Biochemistry. The successful candidate will work with Dr P. D. G. Dean on a project entitled: Development of Novel Methods for Interferon Purification.

The post is tenable for 12 months at a salary on the scale £260-£725 per annum.

Applications, together with the names of three referees, should be received not later than 1 September, 1982. By The Registrar, The University, PO Box 147, Liverpool L69 3BX, from whom further particulars may be obtained. Quote Ref RV/785/NS.

**OPPORTUNITIES FOR
LIFE SCIENCE GRADUATES
AT WYETH LABORATORIES**

Wyeth Laboratories is a pharmaceutical company with wide interests in the development, manufacture and marketing of medicines and nutritional products.

1. The scientific information group provides information support to the Research, Medical and Marketing Divisions and to prescribers, by providing literature searches, reviews and information in response to technical queries. A vacancy now arises for an information scientist to join this group of four graduates. The successful candidate will hold a degree in pharmacy, pharmacology or other life science and will preferably have experience of scientific information in the Pharmaceutical Industry. An MSc in Scientific Information would also be considered an advantage.
2. The registration group is concerned with regulatory approvals in UK and Ireland, including the compilation of applications using scientific reports from the Research Division. This group has a vacancy for an additional registration officer. Experience in registration would be an advantage but is not essential. A high level of ability to organise scientific material and to write clearly and concisely on scientific matters is essential.

Both these posts are based at our head office at Taplow near Maidenhead in a pleasant rural setting and with easy access to the M4 motorway. The salary offered will relate to age and experience within the range of £5850 to £9500 per annum. Other terms and conditions of service are commensurate with those expected of a large international company.

For further details and an application form please contact:
Miss Clare Bradshaw, Personnel Officer, Wyeth Laboratories,
Huntermore Lane South, Taplow, Nr. Maidenhead,
Berks SL6 0PH.
Tel: Burnham (06286) 4377 Ext 4265
Ref: MD/7.



Wyeth Laboratories

MRC

**NEUROPSYCHIATRY RESEARCH LABORATORY,
WEST PARK HOSPITAL, EPSOM, SURREY**

RESEARCH ASSISTANT

Applications are invited for this research post (available for 3 years) to assist in investigations of amine recognition sites and transport processes in platelets and lymphocytes of patients suffering from depressive illness.

Salary scale £4958-£6993 p.a. plus £527 p.a. London Weighting. Further information available from Dr K. Wood (Tel Epsom 24771).

Application forms available from District Personnel Department, Rosebery, West Park Hospital, Horton Lane, Epsom, Surrey.

Telephone Epsom 41420 ansafone
or 40299/40397. Closing date
10 September, 1982.

Surrey Health Authority

UNIVERSITY OF BRISTOL

H. M. Willis Physics Laboratory

Applications are invited for a

**RESEARCH
ASSISTANT**

on the SERC IB scale from Chemistry graduates (BSc, or HND) whose degree course contained a total of 120 credits in the component. The successful candidate will be required to prepare specialised compounds containing stable isotopes for neutron diffraction work. The post will involve investigating various methods of synthesis and the candidate appointed will be expected to work primarily on his or her own initiative. Experience of working with gloves and ion-exchange columns would be an advantage. The post is funded for two years from 1 October, 1982 in the first instance, and the starting salary will be in the range £6375-£8085 p.a. depending on age and experience.

Applications, which should contain the names of two persons to whom reference may be made, should be sent to Professor J. E. Enderby, H. M. Willis Physics Laboratory, Tyndall Avenue, Bristol BS8 1TL, as soon as possible.

**UNIVERSITY COLLEGE OF
NORTH WALES, BANGOR**

**RESEARCH FELLOW:
BACTERIAL PLASMIDS**

Applications are invited from molecular biologists/microbial geneticists with postdoctoral experience in recombinant DNA technology to work on the analysis of bacterial plasmids determining the catabolism of aromatic hydrocarbons. The research will be undertaken in Bangor in collaboration with Dr P. A. Williams, but the person appointed will also be involved in advisory capacity with Shell Research at Sittingbourne.

The appointment, which is funded by Shell, will be for one year in the first instance (renewable for a further two), will commence on 1 October, 1982, or such other earlier date by arrangement, and will be an initial salary of £10 240 per annum.

Applications (two copies), giving details of qualifications and research experience, together with the names and addresses of two referees, should be sent to the Assistant Registrar (Personnel), University College of North Wales, Bangor, Gwynedd LL57 2DG, as soon as possible. Informal enquiries may be made to Dr Williams on Bangor (0248) 51151, ext 315.

**CHARING CROSS HOSPITAL
MEDICAL SCHOOL**

(University of London)

RESEARCH TECHNICIAN

Applications are invited for the post of Research Technician to join a group investigating the cellular and biochemical effects of cigarette smoke on lung tissue components. The post will be for one year in the first instance with the option to renew. Applicants should have a degree in biochemistry, cell biology or related science and preferably some research experience. Previous experience with electron microscopy, immunology or protein isolation techniques will be an advantage.

Salary within range £4958-£6993 per annum plus £527 per annum London Weighting.

Enquiries should be made to Dr T. Dea, Tettes, Department of Medicine, on ext 2566, and applications on forms obtainable from The Secretary, Charing Cross Hospital Medical School, The Reynolds Building, St Dunstan's Road, London W1P 8LP, within three weeks of the appearance of this advertisement.

Novel Silicon Devices

THORN EMI's Central Research Laboratories at Hayes — one of the world's leading innovative research establishments — require a Senior Research Physicist/Engineer to be responsible for silicon circuit design and fabrication in a newly formed department specialising in the development of novel discrete devices.

You should be well qualified in Physics or Electronics and have

2 or more years relevant experience which includes the supervision of graduate staff and apprentices.

You will be joining a highly qualified and competent team working in a stimulating environment which encourages initiative and inventiveness.

To apply, please write (enclosing full cv) to Neil Robotham, THORN EMI, 135 Blyth Road, Hayes, Middlesex or telephone him on 01-573 3888 extension 3016.



THORN EMI Central Research Laboratories

ROTHAMSTED EXPERIMENTAL STATION Harpenden, Herts AL5 2JQ MICROBIOLOGIST

required to join a large multidisciplinary team in the Entomology Department working on the degradation of organic wastes by earthworms, aimed at the production of bulk plant growth media and protein for livestock feed. The appointee will need to have an imaginative approach to do research on microorganism/worm interactions and link this with the agricultural requirements of large-scale waste utilisation. The appointment will be for two years with the possibility of extension.

Qualifications: 1st or 2(1) honours degree in microbiology or microbiology/zooology with at least two years' suitable postgraduate experience and preferably a PhD.

Appointment in the Higher Scientific Officer grade (£6400-£9120) according to qualifications and experience. Non-contributory superannuation.

Apply in writing to the Secretary giving names and addresses of two referees and quoting ref no 459 by 3 September, 1982. Further details on request.

ROYAL HOLLOWAY COLLEGE

(University of London)
POSTDOCTORAL RESEARCH
ASSISTANT BIOCHEMISTRY

Research Assistant to work with Dr R. A. Dixon for three years on an ARC financed project concerning enzymic changes in relation to phytoalexin accumulation in French Bean. Candidates should have a sound knowledge of enzymology.

Salary scale £8260-£9120.

Applications, two copies with curriculum vitae and names and addresses of two referees, should be sent to: Mrs D. J. Odds, Royal Holloway College, Egham Hill, Egham, Surrey TW20 0EX.

THE DEPARTMENT OF NEUROCHEMISTRY MAX-PLANCK-INSTITUTE OF BIOPHYSICAL CHEMISTRY GÖTTINGEN, FED. REP. OF GERMANY

Invites applications for:

- post-doctoral position in the Electron Microscopy Unit for 1-2 years, with possible further extensions;
- a technical assistant.

Qualifications:

- candidates should have prior experience in electron microscopy; experience in immunohistochemical techniques at the light and electron microscopic levels an advantage;

- a biochemical in biochemical techniques; the post would suit a biochemical graduate not planning to continue to the PhD.

Curriculum vitae and references to be sent to: Dr V. P. Whittaker, Abt 10, MPI für Biochemische Chemie, Postfach 968, D-3400 Göttingen, FRG. Salaries on BAT 1b & Vb scales according to age and family status.

UNIVERSITY OF ABERDEEN Department of Bio-Medical Physics and Bio-Engineering LECTURER IN BIO-MEDICAL MECHANICS

Graduate mechanical engineer, preferably with training and experience in Bio-Medical Mechanics, to lead small collaborative research group and teach up to postgraduate level, with administrative responsibility for departmental mechanical workshop. The appointment is tenable for two years in the first instance.

Salary on Lecturer Scale £6070-£12 860 (per annum) with appropriate placing.

Further particulars and application forms from the Secretary, The University, Aberdeen, with whom applications (two copies) should be lodged by 10 September, 1982.

IMPERIAL CANCER RESEARCH FUND

SCIENTIFIC

REQUIRED: IMMUNO-ANALYST
by our Biomedical Computing Unit to work with ICRF scientists on the design and implementation of a computer system for the capture, analysis and management of laboratory data. Facilities on our DEC 20/80 mainframe are exceptional and the post is within an active research group working on projects including software for genetic engineering research and medical application of artificial intelligence (expert systems).

Graduate or equivalent with a science training and programming experience. Knowledge of an algorithmic language, image or signal-processing systems or assembly-language would be an advantage. Salary range £6045-£9425 (revision pending). For further information and application form write to or telephone Mr S. M. Hurley, Imperial Cancer Research Fund, Lincoln's Inn Fields, London WC2 on 242 0200 ext 305. Quoting reference 105/82.

DATA PROCESSING (Typesetting Applications)

An opportunity exists for a

Programmer

to head up a small team converting data to a form suitable for typesetting. Knowledge of printing and typesetting with Norsk Data, Digico or Apple Systems helpful.

Salary negotiable.

Applications in writing, with full CV, to The Managing Director, Alden Press Ltd, Osney Mead, Oxford OX2 0EF.

THE UNIVERSITY OF LEEDS

Department of Physical Chemistry

"Kinetics of gas phase reactions"

A LABORATORY TECHNICIAN

is required (an appointment for two years) to assist in a research programme. Depending upon experience and qualifications of the applicant, the post would be at Grade 5 or Grade 3, and the job description for each grade is available on request. Duties involve operation, maintenance and modification of equipment which includes vacuum lines, mass spectrometer, electronic and spectroscopic equipment. Applicants should have a minimum qualification (in chemistry or physics) of HNC, HND or HTEC and a minimum of eight years' appropriate experience for a Grade 5 post; and a minimum qualification of ONC, OND or TEC and a minimum of three years' appropriate experience for the Grade 3 post. Salary for Grade 5 on a scale £5685-£6650 per annum (under review) and for Grade 3 on a scale £4672-£5475 per annum (under review). Applications including details of qualifications and experience and the names of two referees should be sent as soon as possible to Dr D. L. Baulch, Department of Physical Chemistry, The University, Leeds LS2 9JT, from whom further particulars can be obtained.

UNIVERSITY COLLEGE OF NORTH WALES, BANGOR

TEMPORARY LECTURER: PHYSICS

Applications are invited for the above appointment in the School of Physical and Molecular Sciences, which will be for two years in the first instance but with the possibility of extension for a further two years. Salary on the scale range: £5375-£7225 per annum.

The successful applicant is likely to have postgraduate experience in solid state physics research. Previous teaching experience would be an advantage.

Applications (two copies), giving details of qualifications and research/teaching experience, together with the names and addresses of three referees, should be sent as soon as possible to the Assistant Registrar (Personnel), University College of North Wales, Bangor, Gwynedd LL57 2DG. (Informal enquiries may be made to Professor C. J. M. Strirling on Bangor 0248 5151, ext 225.)

Applications will only be acknowledged if accompanied by a.s.a.e.

THE ROYAL MARSDEN HOSPITAL

Fulham Road, London SW3

MEDICAL PHYSICS

TECHNICIAN GRADE III

required in the Radiotherapy and Physics Electronics Workshop of the above Hospital. The person appointed will work in a small group responsible for the maintenance of radiotherapy equipment including three Cobalt units, a Philips Mobile Linear Accelerator and orthovoltage X-ray equipment. Applicants should have experience in electronics and in electrical and mechanical servicing.

Applicants should hold ONC, HNC or similar qualification in electrical engineering or electronics and have at least ten years' relevant technical experience.

Salary on scale £6468-£8087 per annum (pay award pending).

For an application form and job description please contact the Personnel Department—Tel: 01-552 8171 ext 446.

Indexer

required for the

ZOOLOGICAL RECORD

—an annual bibliography of the world's zoological literature

The post involves scanning and indexing literature from all over the world, to produce input for a computer based operation, with some involvement in checking computer output of processed material.

Applicants should possess a degree in Zoology or an allied subject (where zoology forms part of the degree course) and should preferably have some linguistic ability.

Salary starts at £5400 for a 35 hour week and includes 4 weeks paid annual holiday.

Handwritten applications, giving details of qualifications and career to date, should be sent as soon as possible to:

Administrative Manager

BIOSIS, U.K. LIMITED,

44, High Street, Boston Spa,
Wetherby, West Yorkshire LS23 6EA.



PHYSICIST OR MATERIALS SCIENTIST

The Physics Section has a vacancy for a person to work as part of a small team currently working in the area of strength of, and protective coatings for, glass surfaces, and to take charge of part of the programme of work in this area. The Section also carries out a wide variety of consultative and contract work which it is seeking to expand; the main areas being strength testing, physical property measurements, X-ray analysis and petrological investigations. The successful applicant would be expected to become familiar with some of the techniques involved.

Candidates should have a relevant degree; some experience in the field of glass science would be an advantage.

Salary will be negotiable depending on qualifications and experience.

Letters of application, together with a curriculum vitae, should be sent to Christine Harrison (Mae), to arrive by 3 September, 1982. Please quote reference JBW/CMH.



The British Glass Industry Research Association
Northumberland Road, Sheffield, S10 2UA

ROTHAMSTED EXPERIMENTAL STATION Harpenden, Herts AL5 2JQ SCIENTIST

The Soil Survey of England and Wales (Derby Centre) requires a scientist to assume responsibility for applied soil physics, and to supervise its Soil Water Laboratory. Aptitude for modern data handling techniques essential. Programming experience and knowledge of electronics desirable.

Qualifications: Degree in an appropriate subject for appointment at SO, Degree or HNC in an appropriate subject with at least five years' relevant postgraduate qualifying experience for appointment at HSO.

Appointment in the grade of Scientific Officer (£5422-£7309) or Higher Scientific Officer £6840-£9126), according to qualifications and experience. Non-contributory superannuation.

Apply in writing to the Secretary giving names and addresses of two referees and quoting ref 492 by 3 September, 1982. Further details on request.

MID-SUSSEX WATER COMPANY

ANALYST £6420-£7182

Applications are invited for the above post based at the company's Barmcote laboratory, north of Lewes. The laboratory provides chemical and biological services to the company for varied raw waters and treated waters for public supply. The person appointed will be responsible for the day to day running of the laboratory under the direction of the company's works chemist. It is anticipated that the successful applicant will be educated to HNC standard in chemistry (or equivalent) and have had experience in an analytical laboratory preferably within the water industry. Experience in atomic absorption spectrophotometry is essential. Five day week. This post is superannuable.

Please write or telephone for application form to Mid-Sussex Water Company, Church Road, Haywards Heath, West Sussex RH16 3DX (tel: Haywards Heath 457711). Closing date 31 August, 1982.

Ground Probing Radar

KILLINGWORTH

up to £9,794

We are looking for an innovative R&D engineer or physicist to contribute to the development of a microwave system aimed at locating buried cables and metallic or plastic pipes. The challenge to technical ingenuity is considerable, as such a device will have to work in a high clutter, high attenuation environment. Consequently, a sound knowledge of wide band-width microwave systems design, with particular emphasis on signal processing is important. Ideally, the candidate should have an awareness of broadband antenna design techniques, the microwave properties of materials and imaging techniques.

The successful candidate will be expected to work in a small project group and make a major contribution to the technical progress of the work. He or she will be encouraged to develop their professional skills and a flexible and innovative approach to the work is essential.

The minimum educational requirements are an honours degree in Electrical or Electronic Engineering, or Physics and membership of the appropriate professional Institution is desirable.

Starting salary will be within the range £8,510 - £9,794 (currently under review) and conditions of service are excellent.

Please telephone or write for an application form, quoting ref ESR/217/NS, to: Senior Personnel Officer, British Gas Engineering Research Station, Killingworth, Newcastle upon Tyne NE99 1LH Tel: [0632] 684828, Extension 348.

BRITISH GAS

UNIVERSITY OF NEWCASTLE UPON TYNE Department of Mechanical Engineering RESEARCH ASSOCIATE

Applications are invited for a temporary three-year post of Research Associate in the Department of Mechanical Engineering, to take part in a research investigation into the measurement and analysis of movements of the human arm. The project, under the direction of Dr G. R. Johnson, Reader in Biomedical Engineering, is financed by SERC as part of their specially promoted programme in Medical Engineering. Applicants should have a good honours degree in physics, engineering or a related discipline and should have research experience.

Starting salary will be in the range £6375-£7225 per annum on the Range 1A scale (£6375-£11 105) according to age, qualifications and experience.

Further details may be obtained from Dr G. R. Johnson, Department of Mechanical Engineering, The University, Stephenson Building, Claremont Road, Newcastle upon Tyne NE1 1RU, to whom applications with curriculum vitae and the names of three referees, should be sent not later than 17 September, 1982.

UNIVERSITY OF GLASGOW Department of Botany RESEARCH ASSISTANT

Applications are invited for an SERC Research Assistant to work on sexual reproduction in the fungi *Phytophthora* and *Pythium*. Applicants having a good honours degree in Biochemistry/microbiology may register for a PhD degree. Initial salary will be £5204 on Range 1B of the scales for Research and Analogous staff.

Applications, naming two referees, should be sent to Dr C. G. Elliott, Department of Botany, University of Glasgow, Glasgow G12 8QQ, as soon as possible.

In reply please quote ref no 4916N.

Expansion of Biotechnology

Searle Research and Development at High Wycombe has a major commitment to biotechnology and currently employs a large number of Geneticists, Fermentation Technologists and Protein Chemists in its recombinant DNA programme. As a result of expansion of this effort we have two new positions in the Fermentation Group.

FERMENTATION TECHNOLOGIST is required to work on the production of compounds of bacterial origin. The work will involve the development to pilot scale of genetically modified strains and will necessitate close liaison with other groups, particularly Bacterial Geneticists. (Ref. R56/SN6).

GRADUATE RESEARCH ASSISTANT preferably with experience in handling fermentors, is required to assist the Fermentation Technologist. (Ref. R56/SN7).

Searle offers excellent salaries and career prospects and benefits include relocation assistance, 4 weeks' holiday per year, contributory pension fund, private health insurance scheme, subsidised cafeteria, and recreation club.

Please apply, quoting the appropriate reference, by sending a detailed c.v. or by obtaining an application form from Miss D. Wardman, Assistant Personnel Officer, Searle Research and Development, Lane End Road, High Wycombe, Bucks HP12 4HL. (Tel. High Wycombe 21124, ext. 3374).

SEARLE

ROTHAMSTED EXPERIMENTAL STATION Harpenden, Herts AL5 2JQ CHEMIST

required in the Chemical Liaison Unit for a period of 18 months to join an interdepartmental group investigating control of potato tuber diseases. The post, funded by the Potato Marketing Board, is intended for research into improved application techniques for fungicides and will involve analytical work on new and established fungicides.

Minimum qualifications: Degree in Chemistry. At least five years' relevant post-qualifying experience is required for appointment as Higher Scientific Officer.

Appointment in grade of Scientific Officer (£3422-£7399) or Higher Scientific Officer (£6840-£9126). Non-contributory superannuation. Apply in writing to the Secretary giving names and addresses of two referees and quoting ref 498 by 3 September, 1982. Further details on request.

DURHAM UNIVERSITY Department of Applied Physics and Electronics

Applications are invited for a
**SERC POSTDOCTORAL
SENIOR RESEARCH
ASSISTANTSHIP**

tenable for three years from October 1982 for work on the theory of Auger recombination in semiconductors and quantum well heterostructures under the direction of Dr R. A. Abram. Experience of Auger and/or many body theory would be an advantage.

Initial salary in the range £6375-£7225 on Range 1A plus superannuation.

Applications (three copies) naming three referees should be sent to the Registrar, Science Laboratories, South Road, Durham DH1 1LE by 24 September, 1982, from whom further details may be obtained.

newscientist

Our busy news department needs an experienced secretary aged 19+ to run its day-to-day affairs. The job involves typing, filing and generally organising the team of journalists who put together the news section of this award-winning magazine. Ability to work on your own initiative is essential and there will also be scope for some routine research in this interesting but demanding post. Salary £5,759-76 pa (under review).

Please contact: Patricia O'Flanagan, New Scientist, Commonwealth House, 1-19 New Oxford Street, London WC1A 1NG (Tel: 01-404 0700 Ext 241).

We are an Equal Opportunity Employer.

**MRC CLINICAL RESEARCH CENTRE
(NORTHWICK PARK HOSPITAL)
WATFORD ROAD
HARROW, MIDDLE
SEX HA1 3UJ**

TECHNICIAN

A Technician, interested in Cellular Immunology, is required to work on a research project to study the genetic regulation of cellular immune responses to weak histocompatibility antigens of the mouse. This involves the production and maintenance of T cell clones and hybrids, an analysis of their antigenic specificity in cytotoxicity assays, and the detailed comparison of the immune responsiveness of the congenic mouse strains of origin. Experience in tissue culture and immunological techniques would be of advantage.

Salary will be within the range £5515-£7550 (inclusive of London Weighing).

Applications with full CV should be sent to Miss B. Shaw, Personnel Officer, Clinical Research Centre, Watford Road, Harrow, Middlesex HA1 3UJ, quoting Ref: 129/24338. Closing date 31 August, 1982.

THE OPEN
UNIVERSITY
FACULTY OF
TECHNOLOGY

Assistant Project Officer - Microprocessor Development

An Assistant Project Officer is required to assist in the development and day-to-day running of a microprocessor development laboratory being set up in the Faculty of Technology. He/she will take responsibility for recommending the purchase of new equipment, ensuring adequate maintenance of existing and new equipment, preparing adequate user documentation for systems, assisting users with technical problems and possibly helping with the design of microprocessor-based products.

Applicants should have a degree or equivalent in electronic engineering and preferably two or three years appropriate experience in the field of microprocessor-based system design.

Salary will be on the 1B scale for other related staff £5550-£9370 plus pension benefits, over 6 weeks annual holiday and good social sporting facilities.

Applications forms are available from Mrs S. McBeatty (4354-2), Faculty of Technology, The Open University, Walton Hall, Milton Keynes, or telephone Milton Keynes (0908) 653941; there is a 24 hour answering service on 653868.

Closing date for applications: 2 September.

NATIONAL INSTITUTE FOR BIOLOGICAL STANDARDS AND CONTROL ELECTRON MICROSCOPY TECHNICIAN

Technician is required to assist in the development of electron microscopical methods for standardisation and control work on viral vaccines and cell culture and associated research work. The electron microscopy unit is part of the Viral Products Division and is equipped with scanning and transmission electron microscopes. The technician would be expected to help provide an electron microscopy service for the whole Institute.

Applicants should be qualified to degree standard or equivalent in microbiology/virology and preferably have experience of electron microscopy techniques and the preparation of specimens together with the associated photographic methods. Experience in virological methods would be advantageous.

Salary scale will be dependent on relevant experience, qualification and age and on either Scale £4688 and/or £4597-£5855 plus £432 London Weighing. For further details and an application form please contact Personnel Officer, National Institute for Biological Standards and Control, Holly Hill, Hampstead, London N6 6LB, quoting reference VP/108. Tel: 435 2222.

Closing date 3 September, 1982.



UNIVERSITY OF CAPE TOWN

Lectureship in Botany

Applications are invited for the above post. Preference will be given to candidates with research experience in either Ecophysiology or Marine Ecology/Physiology. Appointment, depending on qualifications and experience, will be made on the salary scale R12 657 x 780-16 557 x 936-222 173 per annum. In addition a service bonus of nearly one month's salary is payable annually. Staff benefits include 70% rebate on tuition fees for dependants at UCT, generous study leave privileges, a housing subsidy which is now also available to single persons subject to government regulations, pension fund, medical aid and group life assurance.

Applicants should submit a curriculum vitae stating qualifications, teaching and research experience, publications, present salary, the date duty could be assumed and the names and addresses of three referees.

Further information may be obtained either from Miss J Lloyd, S.A. Universities Office, Clarendon House, 278 High Holborn, London WC1V 7HE or the Registrar (Appointments Office), University of Cape Town, Rondebosch 7700, South Africa.

(Please quote Ref No: W/271)

The University's policy is not to discriminate in the appointment of staff on the grounds of sex, race or religion. Further information on the implementation of this policy is obtainable on request.

South Glamorgan Health Authority National Blood Transfusion Service (Wales) St. Fagans, Cardiff

Scientific Officer

Salary £5129 - £6745 pa
dependent on qualifications

An honours graduate in biological or natural sciences (1st or 2nd class) is required for the development of additional immuno-haematological services within the Tissue Typing Department. This is a new post, and the areas of work encompassed will be determined by ongoing clinical needs within the region, and may initially relate to cell-marker analysis and cellular immunology techniques.

Applicants should preferably have experience in a relevant field and be prepared to take part in the normal research and development activities of the Tissue Typing department.

This appointment is for three years.

Application form and job description from:
National Blood Transfusion Service, Rhydylafar,
St Fagans Cardiff CF5 6XF. Tel: 0222 890302.
Closing date: 3 September, 1982.

MEDICAL RESEARCH COUNCIL

Toxicology Unit

Post-doctoral Research Fellow

Applicants are invited for the above post to join a small, enthusiastic group studying early changes in carcinogenesis, with particular reference to gamma glutamyl transpeptidase. A suitable candidate would be someone interested in applying the techniques of (eukaryotic) recombinant DNA research to this biochemically intriguing area of carcinogenesis with possible clinical application.

The post funded by the National Foundation for Cancer Research is available for three years from 1982. Remuneration will be at an appropriate point on the scale for University non-clinical academic staff.

Applications, including a full curriculum vitae and the names of two professional referees, should be sent to: Dr M. M. Manson, MRC Toxicology Unit, Woodmancroft Road, Carshalton, Surrey SM5 4EF (Tel: 01-443 8000), before 27 August, 1982.

MRC

Medical Research Council

THE OPEN UNIVERSITY FACULTY OF SCIENCE



RESEARCH ASSISTANT IN CHEMISTRY

A three-year Research Assistant post is available in the Chemistry Discipline of the Open University, to work with Dr A. R. Bassindale and Dr P. G. Taylor on synthetic and mechanistic aspects of the Peterson carbonyl olefination reaction.

Applicants should hold a good honours degree in Chemistry, or its equivalent, and have an interest in mechanistic organic chemistry. The successful candidate will be encouraged to register for an Open University PhD degree.

This post will be available from 1 October, 1982, for three years only. Salary will be on the Research and Analogous salary scale £5265-£7700 per annum.

Further particulars and application forms are available from the Assistant Secretary (Science) (4456/3), The Open University, Walton Hall, Milton Keynes MK7 6AA, or telephone Milton Keynes (0908) 653481: there is a 24 hour answering service on 653688.

Closing date for applications: 10 September, 1982.

FELLOWSHIPS, GRANTS, SCHOLARSHIPS

THE UNIVERSITY OF BRITISH COLUMBIA

Department of Biochemistry

Postdoctoral Fellowship

Recent PhD (or equivalent) with experience in physical studies of metalloproteins is sought for a project involving preparation and characterisation of non-porphyrin metal-macrocycle-substituted derivatives of myoglobin and hemoglobin. The position is available immediately for an initial appointment of one year (renewal for a second year may be possible). Starting salary is approximately \$16,000.

Applicants should forward a curriculum vitae (including publication list) with names and addresses of three referees to: Dr Grant Mauk, Department of Biochemistry, 2146 Health Sciences Mall, University of British Columbia, Vancouver, BC V6T 1W5, CANADA.

SUNDERLAND POLYTECHNIC Faculty of Pharmaceutical Sciences Department of Pharmaceutical Chemistry POSTDOCTORAL RESEARCH FELLOWSHIPS IN

PHARMACEUTICAL CHEMISTRY

Salary Scale: £6855 to £7692 (LII Equivalent).

Applications are invited for two Post-doctoral Fellowships to work with Dr J. K. Brown, Head of Department Pharmaceutical Chemistry on:

- Post 1. Design preparation and evaluation of potential DNA-intercalating agents.
- Post 2. Evaluation of the use of carrier molecules as a means of targeting drugs to trypanosomes.

Candidates should have experience of synthetic organic chemistry and preferably also of analytical techniques.

An application form and further particulars may be obtained from the Personnel Officer, Sunderland Polytechnic, Langham Tower, Ryhope Road, Sunderland SR2 7EE or telephone Sunderland 76231, Ext. 11. Closing date is 6 September, 1982.

THE AUSTRALIAN NATIONAL UNIVERSITY

Applications are invited from suitably qualified persons for appointment to the following positions:

Research School of Physical Sciences
PROFESSORIAL FELLOW IN SURFACE PHYSICS

The University has established a Professorial Fellowship in Surface Physics to be located initially in the Department of Applied Mathematics.

It is anticipated that the appointee will lead diverse theoretical and experimental research in the following areas: Surface Science in Colloid and Surface Science in that Department and in the Department of Experimental programmes in collaboration with the Department of Physics and the Atomic and Molecular Physics Laboratories.

Closing date: 15 October, 1982.
Conditions of appointment: Salary \$440 786 per annum. Current exchange rates: £1 S15 = £1000. Appointment will be to retiring age.

Reasonable appointment expenses are paid. Superannuation benefits are available for applicants who are eligible to contribute. Assistance with accommodation in Canberra is provided for an appointee from outside Canberra. The University reserves the right not to make an appointment or to make an appointment by invitation at any time.

Prospective applicants should write to the Registrar of the University, PO Box 4, Canberra, ACT 2600, Australia, or to the Association of Australian Universities (Apts), 36 Gordon Square, London WC1H 0PF, for further particulars before submitting applications.

THE ANIMAL VIRUS RESEARCH INSTITUTE TWO RESEARCH FELLOWSHIPS

(supported by the Wellcome Foundation), tenable for three years. The successful candidates will take part in a programme to investigate the physical and chemical structure of foot-and-mouth disease virus, with the aim of relating the structure to its immunological activity.

For one of the two posts the candidate should hold a PhD degree and preferably have previous experience in virology and physical chemistry. Salary £6040x2 to £7576.

The second post is suitable for students graduating this year and opportunity will be provided to study for a higher degree. Current basic grant £2535 plus other agreed reasonable expenses.

Application forms and further particulars from the Secretary, Animal Virus Research Institute, Pirbright, Woking, Surrey GU24 0NF. Tel: (0483) 232441. Closing date 17 September.

UNIVERSITY OF KEBLE Department of Chemistry

2-Year Post-Doctoral Research Fellowship

A versatile, resourceful organic chemist is required for Professor J. P. Macleod's Polymer Group to assist in the development of polycyclic polymeric materials. The successful candidate will have a PhD or equivalent research experience and be familiar with infrared, ultraviolet, mass spectrometric and other analytical techniques. Salary appropriate to experience and according to SERC scale (A to G) £2070 per annum.

Applications with C.V., publications list, full personal details and names of two referees should be sent to the Secretary, University of Keele, Keele, Staffs. ST5 5BG, as soon as possible and not later than 15 September, 1982. Applications will be marked PDRA.

UNIVERSITY OF LEICESTER

IC/UNIVERSITY JOINT LABORATORY

Applications are invited for a

Post-Doctoral Fellowship

in a group studying the regulation of mammalian gene expression.

Recent work in the laboratory has led to the identification and characterization of several mammalian genes. In the near future we wish to study the mechanisms of *in vitro* manipulation, into animal cells in order to study their expression and in control. We are now seeking a post-doctoral associate with appropriate experience at the molecular and cellular biology of animal systems to help with this work.

The salary will be on the research and analogous scale, £6070-61573, and the appointment will be for up to three years, with a possibility of extension. Applicants should send a curriculum vitae and references to the Secretary of the University of Leicester, University of Leicester, Leicester LE1 7RH.

THE UNIVERSITY COLLEGE OF WALES

Aberystwyth School of Biological Sciences

POSTDOCTORAL FELLOWSHIP

Applications are invited from suitably qualified candidates in the field of the development of population dynamics for the Davies Trust Research Fellowship tenable at the University of Wales, Aberystwyth. The project concerns the population dynamics and dispersal of salmonids in small upland lakes in Mid-Wales. Applicants must have a current driving licence.

The post is funded from 1 October, 1982, for an initial period of one year. Salary according to age and qualifications.

Applications together with a curriculum vitae and the names and addresses of two referees should be sent to: The Registrar, The University of Wales, Old College, King Street, Aberystwyth, SY23 2AX. Closing date for applications: Friday, 17 September, 1982.

STUDENTSHIPS

UNIVERSITY OF BATH SCHOOL OF ENGINEERING

RESEARCH STUDENTSHIPS

Applications are invited for the following research studentships in the School of Engineering with First class or Upper second class honours.

1. SERC CASE: Computer Applications in Manufacturing Systems

Applicant should have enthusiasm, management potential and preferably some industrial experience. To work on a joint project with a leading high precision batch-manufacturing firm based in the South of England. Contact Dr P. J. Sackett.

2. SERC CASE: Vibration Isolation Suspension Systems for Patients in Ambulances

A joint project with Bath Institute of Medical Engineering. Applicants should have strong interests in vibration and instrumentation and computing, to carry out theoretical analysis and experimental work. Contact Dr R. W. Stammers.

3. University Studentship: Application of Computer Aided Engineering in the generation of Data-bases for CAD

Applicants should have preference for mechanical engineering design and application of computers to the design selection method for component optimisation. Contact Dr C. Vignoli.

Studentships are awarded initially for one year, and are renewable annually up to a maximum of 3 years. The successful candidate will be enhanced beyond the normal SERC scale by the co-operation of the University. Further details and application forms from the Secretary, School of Engineering, University of Bath, Claverton Down Bath BA2 7AY (025) 81641 ext 27.

THE SCHOOL OF PHARMACY

University of London Toxicology Unit Pharmacology Department RESEARCH STUDENTSHIP

Applications are invited for a research studentship funded by the Cancer Research Campaign, tenable from October 1982, to read for a PhD degree. The research will concentrate on biochemical differences between normal and tumour tissues to aid in the design of selectively toxic anticancer agents.

Applicants should possess a First or Upper Second Class Degree in Biochemistry or related discipline.

Applications, including curriculum vitae, and names of two referees should be sent to: Dr G. M. Asher, Toxicology Unit, Department of Pharmacology, School of Pharmacy, 29/39 Brunswick Square, WC1N 1AX. Tel: 01-537 7651; ext 711.

Closing date: 17 September, 1982.

UNIVERSITY OF CAMBRIDGE

Department of Physical Chemistry

RESEARCH STUDENTSHIP IN INFRARED LASER SPECTROSCOPY

Applications are invited for a research studentship in infrared spectroscopy using a tunable diode laser. The aim of the project is to develop tunable infrared diode lasers in highly sensitive spectrometers for detecting gaseous air pollutants. The project involves spectroscopy of transient molecules. The work is supported by a grant from the Royal Society of Chemistry (Analytical Chemistry Trust Fund) and is tenable for the three years from October 1982. Remuneration and conditions of appointment are equivalent to standard SERC awards.

Further particulars from: Dr P. B. Davies, Department of Physical Chemistry, University of Cambridge, Lensfield Road, Cambridge CB2 1EP.

UMIST ANALYSIS OF ATMOSPHERIC VAPOURS USING OPTICAL WAVEGUIDE TECHNIQUES

Applications are invited for a SERC Studentship from candidates holding a first class honours degree in Chemistry, Physics or a related subject. The successful applicant will register for a PhD and the project will last three years starting 1 October, 1982.

Letters of application, including a full curriculum vitae and the names of two referees, should be addressed to Dr J. F. Davidson, Department of Instrumental and Analytical Science, UMIST, PO Box 88, Manchester M60 1QS. Further details and application information is available. Please quote reference IAS/51/A.

UNIVERSITY OF LIVERPOOL

School of Dental Surgery

RESEARCH STUDENTSHIP

A position is available for a biochemist or microbiologist to pursue research on the interaction of carbohydrate and nitron metabolism in dental plaque in situ, under the supervision of Professor W. M. Edgar. The studentship is suitable for study towards a higher degree.

Applications, together with the names of two referees, should be received not later than 2 September, 1982, to the Registrar, The University, PO Box 147, Liverpool L69 3BX, from whom further particulars may be obtained. Quote ref: RV78/2NS.

UNIVERSITY OF NOTTINGHAM

Department of Applied Biochemistry and Food Science RESEARCH STUDENTSHIP

A studentship has become available to study the role of polysaccharides in food extrusion. This research is directed towards the production of meat analogues from vegetable proteins. The successful applicant will be part of a group investigating various aspects of food technology.

The project is multidisciplinary in character and applicants are required to have backgrounds in chemistry, biophysicists, food scientists or polymer technologists with a 2:1 or superior degree.

The studentship is tenable for three years and should lead to a PhD. A grant based on the normal SERC scale will be paid.

Applications together with the names of two referees should be sent to the Secretary, Dr J. R. Mitchell, Food Science Laboratories, School of Agriculture, University of Nottingham, N. Loughborough, Leics.



Amersham International and The University, Southampton

SERC CASE studentship in Chemistry

Applications are invited for the SERC CASE studentship available for 3 years and leading to the degree of PhD. The project will involve the synthesis and characterisation of polymer inhibitors labelled with radioisotopes, and the assessment of their potential for diagnostic use in nuclear medicine.

Further details may be obtained from: Dr P. Wynn, Department of Chemistry, The Southampton SO9 3NH.

BRUNEL UNIVERSITY

Applications are invited for THREE POSTGRADUATE STUDENTSHIPS

In the department of biochemistry.

The areas of study are (1) prostaglandin biosynthesis in normal and cancer cells; (2) the production of lipid peroxidation in relation to cellular injury and DNA synthesis; (3) the role of the P-450 drug metabolising system and activation of carcinogens. The projects form a part of a multidisciplinary biochemical research programme.

Applicants should have good honours degrees in biochemistry or biological sciences. For further details contact Dr A. Garner or Dr G. Donald Gibson, Dept of Biochemistry, Brunel University, Uxbridge UB8 3PH.

UNIVERSITY OF LANCASTER

Department of Chemistry RESEARCH STUDENTSHIP

Applications are invited for a Ministry of Defence sponsored research studentship tenable for three years.

The research is concerned with the solution and solid state behaviours of co-ordinating polymers.

Candidates should possess a good honours degree, or equivalent, in chemistry.

Further details are available from Dr D. J. Hourston, Department of Chemistry, University of Lancaster, Bailrigg, Lancaster, Lancashire LA1 4YA.

MRC CLINICAL RESEARCH CENTRE
(NORTHWOOD PARK HOSPITAL)
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HA1 3UJ

RUCA/CASE RESEARCH STUDENTSHIP

Applications are invited for a joint SERC Studentship between the Division of Cellular Cell Biology, MRC Clinical Research Centre, Harrow, Middlesex, and Cell Tech Ltd, Slough.

Research proposals include isolation of monoclonal antibodies to lymphocyte surface enzymes and their use in the diagnosis of lymphocyte disorders and in studies of the role of these enzymes in lymphocyte physiology.

Further details and application forms from the Personnel Officer, quoting Reference 1043/CASE, Clinical Research Centre, Watford Road, Harrow, Middlesex. Closing date 31 August, 1982.

STUDENTSHIP

**LONDON SCHOOL OF HYGIENE
AND TROPICAL MEDICINE**
(University of London)

Department of Medical Microbiology

Applications are invited for a SERC/CASE Studentship to study extrachromosomal genetic elements in the causative agents of whooping cough, Bordetella pertussis, with a view to developing the genetics of this organism. The project will be carried out in collaboration with the Molecular Genetics Laboratory at the Centre for Applied Microbiology and Research, Porton Down, Salisbury, and will be jointly supervised by Dr D. A. Broadbent (LSHTM) and Dr C. D. Dingle (CARR).

Applicants should hold a first or upper second class honours degree in an appropriate subject.

Applications, including a curriculum vitae and the names of two referees, should be sent to: Dr D. A. Broadbent, Department of Medical Microbiology, London School of Hygiene and Tropical Medicine, Keppel Street, Gower Street, London WC1E 7HT.

UNIVERSITY OF CAMBRIDGE

Department of Applied
Biology

SERC STUDENTSHIP

Applications invited from graduates with the least upper second class honours degrees in appropriate subject to investigate 'Responses of neurophysiological systems to behaviour modifying chemicals' starting October 1982.

Further particulars from and applications with names and addresses of two referees to the Secretary, Department of Applied Biology, Pembroke Street, Cambridge CB2 3DX, as soon as possible.

**NATIONAL FOUNDATION
FOR CANCER RESEARCH**
(U.S.A.)

An N.F.C.R. Postgraduate Research Studentship

will be available from October 1982 for 3 years in the research group of Dr C. Thorne. Researcher fees will be paid by the N.F.C.R. and the value of the studentship will be the same as an SERC Studentship.

The research work of the group, in St Andrews is concerned with the application of quantum chemical methods to problems in the molecular aspects of cancer, and is carried out in collaboration with the other N.F.C.R. laboratories around the world. The majority of the calculations involve the use of sophisticated ab-initio methods using the VAX/780 computer.

Applications, with the names of two referees, should be sent as soon as possible, no later than 13 September, 1982 to the Regional Director of Research, Dr C. Thorne, at the Department of Chemistry, University of St Andrews, St Andrews, Fife KY16 9ST.

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LECTURES, MEETINGS AND COURSES

MICROBIOLOGY

Microbiology Course leading to a Technician Education Council (TEC) single subject award. One afternoon or evening per week for one or two years. **Science Department, Hounslow Borough College, St. John's Road, Isleworth, Middlesex. 01-548 8244.**

University of Manchester

NUCLEAR POWER TRANSPORT AND WASTE

A review programme of 11 days, with emphasis on Public Health, held in Manchester every alternate month in 1982. Course fee £45. Presented also at other centres by arrangement.

Detailed brochures and dates from: Miss N. Green, Radiological Protection Service, University of Manchester, Manchester M13 9PL. Tel: 061-273 3333.

BRITISH COUNCIL MEDICAL COURSES

THE LYMPHOCYTE

23 January-4 February 1983 in London

This course aims to familiarise participants with the latest advances in Britain in the immunology of the lymphocyte and to update their knowledge of current concepts of the role of the lymphocyte in adaptive immunological processes.

The Directors of Studies will be PROFESSOR I. M. ROITT and DR P. M. LUDYARD of the Middlesex Hospital Medical School, London. The course is aimed at postgraduates who are laboratory investigators or clinicians with 2-3 years' experience in immunology or allied fields.

Fee £445 (Residential), £375 (Non-residential).

MEDICAL IMMUNOLOGY: RECENT ADVANCES

13-25 March 1983 in London

This course is expected to interest senior immunologists, microbiologists, pathologists, epidemiologists and clinical specialists with established experience in the diagnosis, management and control of immunologically-based disease in paediatric and adult clinical practice. It will aim to consider the clinical impact of recent advances in molecular and cellular immunology upon the understanding of immunological disease processes, on immunodiagnosis, treatment, and immunoprophylaxis.

The Director of Studies will be PROFESSOR D. C. DUMONDE of the Department of Immunology, St Thomas's Hospital Medical School, University of London.

The course is intended for senior immunologists, microbiologists, pathologists, epidemiologists and clinical specialists with established experience in the diagnosis, management and control of immunologically-based disease in paediatric and adult clinical practice.

Fee £695 (Residential), £405 (Non-residential).

Further information and applications forms can be obtained from your local Overseas Representative of The British Council, or from Courses Department, The British Council, 65 Davies Street, London W1Y 2AA.

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A R I A D N E

FEARLESSLY striking out at a seminar organised by the Advertising Association, the Director General of Fair Trading, Sir Gordon Borrie, said he thought the ethics of suppliers offering incentives or inducements to individual members of a company's purchasing staff with a view to increasing their sales were highly dubious. He added that the employees to whom the incentives were offered had the responsibility either for ordering goods or services themselves or for making sufficiently strong recommendations to influence the course of the purchasing decision. And words, words, words to that effect, showing a good grasp of pompous language guaranteed to obscure meaning, weaken argument and bore the behinds off his audience—if it had been a normal one.

He was talking about bribery, chaps. Or should I say the thrust of his address was anti-acceptance of offered inducement for personal gain? □

TYPICAL, I thought, of my ignorance of what goes on in the world. I had missed the item, which must have been in all the papers, that Sir Harold had upsticked and abandoned his favourite spot in the UK. It was a headline on a release from the Ministry of Agriculture. It said, "Isles of Scilly: Designation as a less favoured area". Agog, I read on to find that the SCAS of the EEC has made the Decision (capital letter and all) to make the Isles an LFA. But it became confusingly clear that a less favoured area is, as you might expect knowing the EEC, a more favoured area because it is less, if you follow me. Get your area Designated as an LFA and you qualify for grants for agricultural activities, for a start, and headage payments for example. So you see that all is not what it may seem. So appropriately, on to the *Financial Times*, a newspaper of impressive achievement and inside knowledge. How much inside may be revealed by publicity it is circulating about its diary for 1983, order now to avoid disappointment and all that. It spurns ordinary diaries, which, says the FT, you will be using less and less as the year grows longer. There must be a direct line to Higher Authority somewhere in Bracken House, but I think it is scandalous not to have passed this astronomical news on before now and to disclose it in this furtive manner a bit on the disgraceful side. □

HAVING read all the stories about Opren with a mixture of horror and rue, I came out the other end about where I started, opinion-wise as advertising agents tended to say. They, of course, have played rather a large part in getting Opren where it is today.

My opinion may be considered a bit simple, or even rough, but it is based on long experience of watching, with torment, the progress of arthritis in sufferers who were too dear to me for my attitude to be entirely objective.



I do not want to tread on any medical toes and I know that devoted researchers are trying to crack the mystery of the disease. I have known that, from close quarters for twenty years. During that time I have been alternately optimistic and gloomy as one alleged advance after another turned out to be nothing of the kind. That does not mean I blame anyone for not finding the key to the puzzle. I am not so sure about those who advertise drugs, with pictures, for instance, of crippled people before and relatively lissome people after being put on a course of the latest anti-arthritis molecule.

At last, my opinion. Keep off drugs as much as you can, if you have rheumatism. If you have to take pain killers, there is nothing better than aspirin. □

TWO developments have caught my eye recently that are worth a toast or two, in my opinion. The first is that salmon are back in the Thames. After introducing thousands of fry into the river since 1979 the Thames Water Authority is celebrating the return of mature fish. It has caught some by a stunning technique and, even as I write (it is pleasant to be able to use a Victorian phrase every now and then) an angler claims to have caught a salmon by rod and line, though he is not sure it is a salmon, oddly enough. If it is, he gets a prize.

The clean-up of the Thames, which is responsible for the salmon's come-back, is remarkable and has not had the cheers and airborne hats that it deserves. Even speech makers have not brought out the hard to dodge cliché that apprentices once sent in a petition to Parliament, grumbling about having to eat so much salmon in their weekly diet. That was in the 18th century, I think.

The other development is also, I admit, concerned with the table. English wine, up to now, has all been white and though some of it, according to my limited experience, is not bad, none of it is memor-

able. It goes down with a mental cry of "Fancy, English wine! Well, well, just think of wine grown here," and so on to improve its impact. Now I read, a grower near Reading has planted Pinot Noir vines and is having a go at producing red wine in this country.

I have drunk German red wine which was undistinguished, so I have no great hopes about the English. Food and wine conservatives should now read something else. The news about the salmon and the red wine struck me as noteworthy because I like red wine with salmon. People have been ostracised from society for less. □

POLITICS, particularly in a democracy, is a branch of the live theatre. Confrontation, victory and defeat, cliff-hanging suspense, treachery, backsliding and conversion, all are there. This is a great drawback. Even the most dedicated participant must sometimes become aware that party loyalty or past rhetoric has committed him to some manifest absurdity. So in the cause of rational government, Daedalus is planning to introduce into politics the "Delphi" technique used for technological forecasting. Each expert in a group is asked to guess, for instance, when a development will occur, or how much it might cost. The resulting list (devoid of authors' names) is then shown to all the experts, possibly in the form of a statistical distribution. They are then invited to make a second guess in the light of the first and, if they wish, to defend it by argument. The refined guesses and arguments are again presented anonymously to the group. Thus the drama of confrontation is defused. Nobody is publicly committed to a position; nobody feels obliged to defend absurdities or face a humiliating climb-down. It is astonishing how rapidly a balanced consensus emerges.

So Daedalus is devising a computerised version of the technique for Parliamentary, Trade Union and Party Congress use. Each member has a terminal, feeding a central computer which controls a big public display. The usual speeches, the impassioned oratory and indignant denunciation, will still go on, for political instinct must be served, but between them the real private beliefs of the members will be publicly displayed as distributions, voting patterns, or pooled estimates of probability. The resulting decisions may still be quite wrong, of course, but they will be saved from several forms of political silliness. The technology will force the evolution of new procedures, and Daedalus cannot entirely foresee what a computer-democratic meeting will be like. But it is bound to be an improvement on inter-party or employer-union confrontation. In the coming "wired society", with everyone linked to a central broadcasting computer by two-way cables, it could restore the ancient Greek democratic ideal. □

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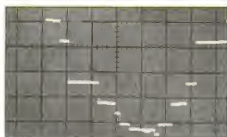
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